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# China Report

POLITICAL, SOCIOLOGICAL AND MILITARY AFFAIRS

INTRODUCTION TO NATIONAL

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CHAPTERS V-VII

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6 September 1985

## CHINA REPORT

## POLITICAL, SOCIOLOGICAL AND MILITARY AFFAIRS

## INTRODUCTION TO NATIONAL DEFENSE MODERNIZATION

## CHAPTERS V-VII

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## Chapter V: THE MODERNIZED NAVY

[Text] 1. The Composition and Combat Characteristics of a Modern Navy

## A. Composition and Mission

In parallel with the modern army, a modernized navy is also a combined force of different service arms; it includes submarine forces, surface combatant vessels, aviation units, coast defense forces, marine and service groups such as signal, radar, sonar, ocean survey, navigation marking, signal maintenance, rescue, anti-chemical warfare, engineering, transportation service, etc.

The navy's surface combat vessel fleet has the longest history and is equipped with the most ships in the modern navy. The surface combat vessels are classified into two categories, i.e. the warships and service or auxiliary ships. A navy's principal warships during the last part of the 19th century were the battleship, cruiser, destroyer, escort destroyer and torpedo boat. Later on, the aircraft carrier, guided missile ship, submarine chaser, mine layer, mine sweeper, mine detector, landing craft, etc. were added into the naval surface fleet. Surface combat vessels are usually equipped with guided missiles, naval artillery, torpedos, mines and depth charges. The navy's auxiliary or service vessels, including tenders, are designed to serve warships or a fleet in action to give them technical and logistic support. There are different classes of vessels in the navy; customarily, any vessel over 500 tons displacement is classified as a ship and under 500 tons as a boat.

The submarine appeared at the end of the 19th century. From the turn of the century up until the 1950s, all submarines were equipped with conventional power plants (diesel-electric type) and used to attack surface vessels or other submarines. In the mid-1950s, the nuclear

powered submarine appeared on the scene; in the early 1960s, the ballistic missile equipped nuclear-powered strategic submarine and the cruising guided missile and torpedo equipped nuclear-powered attack submarine were developed.

Naval aviation started in the early part of the 20th century when the airplane was developed. Presently, a navy has ship-board and shore-based aircraft and seaplanes.

The coast defense force is equipped with coastal artillery and ground-to-ship guided missile. The marine corps is equipped with landing craft and amphibious armored vehicles.

Since the mid 1950s, there have been some great changes in naval weaponry and equipment:

(1) Some of the naval vessels became nuclear powered; examples are: nuclear submarine, aircraft carrier and cruiser. Nuclear-powered ships carry much more energy than coal and oil can produce on a conventional ship; for instance, a kilogram of uranium 235 can produce heat equal to 2,700 tons of high grade coal. Consequently, a nuclear powered ships refueled once can last 10-15 years; thus, a nuclear powered vessel's cruising radius is increased by leaps and bounds. A modern nuclear submarine's cruising radius can reach 200,000 nautical miles or can circumnavigate the equator nine times or more. A nuclear powered aircraft carrier's cruising radius can reach 400,000-700,000 nautical miles or can circumnavigate the equator 18.5-32 times without refueling. Nuclear powered combat vessels can reach every ocean on earth and engage in combat for extended periods on a single cruise; the conventional combat vessels (usually have a cruising radius of several tens of thousands of nautical miles) can not match that feat.

Due to the high cost of producing nuclear power plants, there are still many ships that use conventional power plants, such as steam turbine, gas turbine, diesel engine or the combination of diesel and steam engine. Because of the gas turbine's characteristics of fast starting and acceleration (it can reach full power within 2-3 minutes), it has been used on small vessels since 1940s and since it is also easy to maintain and repair and has a high degree of automation, it has been installed in many more types of surface vessels since 1950s. Britain was the first nation to install the gas turbine engine on medium to larger sized vessels. The recently built large- and medium-size vessels in the Soviet Union and the USA also use the gas turbine.

(2) Combat vessel weaponry has been gradually shifted to guided missiles. In the past, a combat vessel's weapons were cannon, torpedo, mine, depth charge, etc. Since the 1960s, submarines, surface warships, aircraft and coastal defense forces have all been equipped with guided missiles which have become principal weapons in combat action. Guided missiles can be classified into two categories: a. strategic guided missiles for strategic targets; b. tactical missiles for attacking ships, boats (including submarines), aircraft and ground targets. The strategic guided missiles are usually ballistic missiles with nuclear warheads. A survey indicated that 1/3 of all countries' strategic nuclear ballistic guided missiles are installed on submarines. This is a very powerful striking force (Chapter VII discusses the strategic guided missile exclusively). The tactical guided missiles are installed on surface combatant vessels, submarines, aircrafts and in coastal defense positions and are mainly the cruising type, such as guided missiles of the ship-to-ship, ship-to-submarine, ship-to-air, submarine-to-ship and air-to-ship (or submarine) types. In comparison with artillery and torpedos, the tactical guided missile has longer range, higher accuracy and more firepower. It has become a major weapon in naval warfare; in the future, any naval engagement will start with a duel of guided missiles. The recent Middle East War, Indo-Pakistan War and the war between Britain and Argentina over the Malvinas Isles (Falkland Isles) clearly demonstrated this trend. All nations are developing guided missiles for their navy but in the meantime, they are also trying to upgrade their conventional weaponry as well to form a comprehensive weapon system of new artillery, mines, torpedos and depth charges with guided missiles as the system's mainstay.

(3) Large scale application of electronic equipment on modern naval ships and boats. Many kinds of electronic equipment such as radar, sonar, radio transmitters/receivers, remote sensors, computers, automatic indicators [not specified], etc. have been used in the detection (including reconnaissance) of enemy combat vessels, in communication, navigation and steering, command and control and in operations of neutralizing enemy electronic equipment functions. The large-scale application of electronic equipment is to achieve a higher degree of automation in each function of a warship or to achieve the goal of total automation on a ship; for an example, a large aircraft carrier has several scores of radar for detecting hostile action from sea or air, for navigation, control and guidance, artillery fire-control, IFF radar, etc. and several scores of sonar, radio transmitters and receivers. A survey indicated that 1/5 and 1/3 of a warship's total construction cost is for electronic equipment. Because of the electronic equipment's capability of doubling or tripling

warship's fighting power, all nations are still investing large amounts of money to have more and better electronic equipment on their warships.

A modern navy has components of different arms, many kinds of combat vessels, aircraft, weaponry and equipment; it is versatile in combat and capable of carrying out many kinds of missions: a. to carry out raids against major strategic target, such as economic or industrial centers, military bases and ports; b. to engage in sea battle to destroy or repel enemy sea force in order to control and dominate the area's sea and air; to insure our force's freedom of movement and action in the area; c. to assist and support our army and air force's landing operation and to suppress resistance in the landing zone; d. to guard and protect our coast, naval bases, harbors and other areas; e. to protect and safeguard our sea lanes, fishing industry and sea resources and in the meantime, to disrupt the enemy's sea transportation; f. to impose a blockade against the enemy, but to break the enemy's blockade against us.

#### B. Combat Characteristics

(1) A modern navy can engage its enemy in several areas or dimensions and can carry out a long distance raid. A modern naval engagement, especially a large scale sea battle, is a war between combined fleets of opposite sides that include surface and underwater warships and aviation units. Simultaneously, each side can attack different targets on the surface, underwater and in the air; it is truly a large scale three dimensional warfare. Because of the use of guided missiles, the range of navy firepower is much greater than in the old days. The maximum range of a warship's deck gun is about several tens of kilometers, but a guided missile's range can reach several hundreds of kilometers and carrier-based airplanes can attack a target a thousand kilometers away. Furthermore, the improved fleet supply capability and combat vessels operating radius enable a fleet to engage in sea battles in a distant, remote area. For example, the Malvinas Isles are 13,000 km (over 7,000 nautical miles) away from Britain, but Britain was able to dispatch a large combined fleet of aircraft carriers, submarines, destroyers, frigates and auxiliary ships, a total of over 110 vessels, to the war zone. After 18 days of sailing, the fleet reached the combat zone which was several hundred nautical miles wide and engaged the enemy on the sea, under the water and in the air while the infantry slugged their way into enemy positions on land. This campaign demonstrated clearly the distinct characteristics of a modern naval engagement and it was also called an "epitome of modern sea battles."

(2) The trend of modern naval warfare is heading toward a higher degree of automation. The lightning-speed combat actions in modern naval warfare require quick response to counter hostile action; for example, the interval between the detection of an incoming ballistic missile to its detonation at target is about 80 seconds; an effective counter action has to be executed within a minute and therefore, only automation can meet this requirement. A modern navy utilizes satellite and electronic equipment to carry out reconnaissance; uses remote sensor, radio and onboard electronic equipment to receive, transmit and process the combat intelligence data acquired by the reconnaissance operation automatically. Each link's function in operational control, weapon firing control and vessel steering is also automatized. To make the above-mentioned system work, computers must be used in a combat vessel's command and control center; the computers receive and process the intelligence data and then send out command decisions for carrying out an operation.

The aiming, loading and firing of guided missiles, artillery, torpedoes and depth charge are done by machine while humans control the machine. A combat vessel's power plant is also operated and controlled by machine and therefore, only a few persons are required in the engine control room. Because of this automation, a warship's response time can be shortened greatly and combat effectiveness increased. Currently, the most advanced warship's response time is about 30 seconds (including human action).

(3) Counteracting the enemy's electronic equipment is a critical operation in a modern naval engagement. A modern navy employs a large amount of electronic equipment in reconnaissance, searching for the enemy, communication, navigation, weapon systems and operational control. As the time goes by, the dependency on electronic equipment increases further. In a naval engagement, if one side's electronic equipment is destroyed or jammed by its opponent, the side without functioning electronic equipment would lose its capability in observation, reconnaissance, communication, command and firing weapons and would, therefore, lose the battle.

## 2. Submarine Is Very Suitable for Carrying Out a Surprise Raid

The submaring became a new type of warship in the latter part of 19th century. A submarine can conceal itself well, be fairly self sufficient, has a long cruising radius and is a powerful raider in attacking a medium or large warship. Therefore, submarines have become an important arm of the navy.

The submarine force demonstrated its power and prowess in World War I; it sunk a total of 11,150,000 tons of shipping or 86.6% of both sides' total loss in shipping. In WWII, submarine forces sunk over 300 surface warships and more than 5,000 transports, a total of 14,690,000 tons or 68.1% of both sides' shipping tonnage. The modern submarine force will play even a more important role in the future.

There are many types or models of submarines. According to the design of the power plant, submarines can be classified into conventional and nuclear types and according to the weapons on board, there being guided ballistic missile submarines, guided cruise missile submarines and torpedo submarines. A guided ballistic missile submarine's main weapon system is the guided ballistic missile with nuclear warhead; the ship's primary mission is to attack strategic land targets and therefore, it is also called a strategic guided missile submarine. The cruising guided missile and torpedo submarine's primary mission is to attack surface combatant vessels and therefore, it is also called an attack submarine. Currently, there are more than 700 submarines in the world; among them, more than 140 are strategic guided missile submarines (USA 41, Soviet Russia 95, Britain 4 and France 5); the balance of the 700 are attack submarines.

The silhouette of a modern submarine generally is in the shape of a water drop, a whale or a porpoise. The sleek body design is to reduce water friction to a minimum and to enhance its underwater speed. The modern submarine is several times larger than one in WWII; a nuclear guided ballistic missile submarine's submerged displacement can reach 9,000-18,000 ton; an attack submarine's submerged displacement can be as much as 1,300-7,000 ton. A guided ballistic missile nuclear submarine's interior layout has the following compartments: crew's living quarters, bridge and control cabin in the forward part of the ship; guided missile silos in midship and the power plant in the stern section. While in an attack submarine, the torpedo compartment is in the forward or bow section's; crew's living quarters and bridge are in the mid section and the power plant is in the stern section. However, some attack submarines also have torpedos in the stern section as well.

Submarines usually have double-hull construction; the inner hull or the pressure hull can withstand great pressure and the outer hull is not designed to withstand high water pressure. The main ballast tanks and adjusting or trimming ballast tank(s) are located between the inner and outer hull. Letting water into or expelling water out from the ballast tank controls the vessel's diving or surfacing. When the main ballast tank is full, the submarine's weight equals its submerged displacement and the vessel will be suspended at a desired depth. With the control of the vertical and horizontal rudders and its motive power, a submarine can carry out its functions while submerged. In case of having the vessel setting down on the ocean floor (care should be taken not to exceed the vessel's maximum diving depth) just add more water into the trim ballast tanks, so that the vessel's weight is more than the displacement. To surface, a submarine simply expels the water from the ballast tanks.



Submarine power plants were mainly diesel engine-electric motors during WWII; this type of twin-propulsion conventionally powered submarine usually has a maximum diving depth of 100-150 m, maximum submerged speed of 12 knots per hour and a cruising radius of several thousands to over ten thousands nautical miles. Nuclear powered submarines, using new types of construction material, can have a diving depth of 200-500 m and possibly a maximum depth of 900 meters, submerged speed of 30 knot/hr and a cruising radius of several tens of thousands of nautical miles, several times more than a conventional submarine can achieve.

To insure submariners' normal living, working and combat activities during the submerged condition, the vessel has to carry bottled oxygen, air revitalization equipment, fresh water, provisions and required ammunitions.

#### A. Good Concealment

Good concealment and a long period of submerged capability are the critical requirements for a submarine to conduct mobile warfare. The nuclear powered submarine has better concealment capability than a conventional one.

A conventionally powered submarine is powered by a diesel engine when sailing on the surface and an electric motor (powered by storage batteries) while submerged. If a vessel is going at a submerged maximum speed (generally about 20 knot/hr), its batteries would only last for about one hour and if it is going at a submerged slow speed (about several knots an hour) its batteries could last for several tens of hours or could cover a few hundred nautical miles. When its batteries are discharged, a submarine must find an opportunity to surface and to run the diesel engine for charging the batteries (because the deisel engine requires oxygen to operate). Up until the latter part of WWII, submarines' submerged operation occupied only 15-20% of their total cruising time. It is clear that a conventionally powered submarine's length of submerged time, areas to be covered and operations to be carried out while submerged are very much limited and the chance of being detected by the enemy is high.

Nuclear submarines are powered by a nuclear power plant which uses nuclear energy to produce high steam pressure from water under high pressure to turn the turbine: In turn the turbine drives the propeller to propel the submarine. A nuclear power plant generates high power but requires no oxygen to operate. Therefore, a nuclear powered submarine can be operated under water for long periods of time, sometimes as long as 70 days and can travel at a submerged speed of 30 knot/hr. Its submerged time can be 90% of its total cruising time and the chance of being detected by the enemy is much less than a conventionally powered submarine. The capability of concealment has been increased further after ELF radio communication technology was perfected, allowing a submerged submarine at a certain depth to maintain radio communication with its shore stations.

## B. Strong Attacking Firepower

A submarine's principal weapon was the torpedo with a range of several thousand meters for attacking surface vessels during WWII. The modern submarine, equipped with guided ballistic missiles, guided cruise missiles that can be launched from 20-40m underwater and torpedoes, can attack surface vessels, submerged submarines and strategic ground targets. A guided ballistic missile submarine can have 6, 8, 16 or even 24 missile launchers and can launch different types of guided missiles with nuclear warheads. These guided missiles possess strategic attacking power; their range varies from 1,300-9,000 km and some of them are individually guided multiple-warhead missiles. There is no comparison between present day submarine weaponry and the old days. Modern attack submarines are also equipped with 4-10 guided cruising missiles or torpedos; a guided missile's range is 30-300 nautical miles (55-555 km) and torpedo range is 10,000-40,000 m so that the attacking firepower is greatly increased. An advanced attack submarine equipped with a sophisticated fire-control system can track several targets simultaneously and attack them with torpedos or guided missiles. Nevertheless, a submarine has its weakness also, i.e. its self defense and measures to counter anti-submarine weapons (antisubmarine aircraft or warships and other types of weapons) are inadequate. Basically, its defense against the enemy is negative in nature, e.g. dodging and concealing.

## 3. Aircraft Carrier--Mobile Air Base on Highseas

Modern naval warfare is three dimensional. To control a war zone on the high seas, one must have command of the sea as well as command of the air. In a sea battle, aircraft are one of the critical weapons, but their operational radius is fairly short and they can not operate too far away from their base. In a modern naval warfare, the airplanes need a mobile air base on the sea to keep them flying, the aircraft carrier.

Carrying out long distance air raids has become a basic tactic in naval engagement since the appearance of the aircraft carrier. As early as the 1920s, Britain, USA, France and Japan created their carrier force and the aircraft carrier force was highly developed into a major component of a navy in WWII. During the war, the antisubmarine aircraft carrier and attack aircraft carrier amply demonstrated their power and usefulness. In the past war era, the nuclear aircraft carrier appeared on the scene and the aircraft carrier's developmental trend is to construct multiple-purpose carriers.

## A. A Modern Aircraft Carrier Is the Longest Naval Ship

A modern aircraft carrier is about 270-340 meter long, 40-70 meter wide, 40-70 meter high (from its keel to highest point of the superstructure) and has a draft of 8-10 m (the submerged part of the ship). The mammoth is more than  $\frac{1}{4}$  km long and as tall as a 20-story building; it's a small isle on the ocean. For example, a heavy aircraft carrier displaces 60,000-90,000 tons and has 10 full-length ship decks from

keel to flight deck; the first four decks house power plants, fuel, water tanks and ammunition storage; from the 5th to 10th decks are carrier crew and aviation personnel's living quarters, offices, work-ships and aircraft hangars--there are forward and rear hangars between the 8th and 10th decks. The top deck is the wide and large flight deck which accommodates aircraft takeoff and landing, refueling, battery recharging, arming and other combat preparations. This class of carrier can carry 90-100 planes, a crew of 3,300 or more and an aviation unit of 2,800 officers & EM. An medium aircraft carrier (displacing 30,000-60,000 tons) can carry 70-80 planes while the light aircraft carriers (displacing less than 20,000 tons) have been mostly converted to carry 20-40 helicopters for anti-submarine warfare and many countries now do not list this class as an aircraft carrier.

For the purpose of not letting the operation of takeoff and landing interfere with each other, a flight deck is divided into takeoff and landing areas. A 70-90 meters long runway from the forward deck to bow is designated for takeoff. The landing strip, about 220-270 m long, starts from the stern and extends toward the beginning of takeoff runway; the axis of the landing strip is at an angle of about  $6^{\circ}$ - $13^{\circ}$  with the carrier's fore-and-aft axis and cants toward portside. Therefore, the landing strip is also called a canted flight deck.

There are two powerful catapults at the takeoff airstrip's starting point to assist two planes' takeoff simultaneously and several transverse wires or cables on the landing strip for arresting a plane on landing. Between the hangars and flight deck, there are elevators that are used to remove planes from the flight deck or to send planes up from the hangars. Signal lights are installed on both sides of the airstripes to guide planes during takeoff or landing.

Although an aircraft carrier is the largest surface warship in the navy, it is not a slow ship. A modern aircraft carrier can have a maximum speed of 30-35 knot/hr or the equivalent of an express train's speed (referring to train speed in China). In addition, an aircraft carrier has good maneuverability.

#### B. Aircraft Carrier's Principal Weapon Is the Aircrafts on Board

An aircraft carrier's principal weapons in combat are its planes; there are fighters, fighter bombers, antisubmarine aircrafts, etc. The fighters are mainly used to engage or intercept enemy planes and to destroy incoming guided missiles. The fighters' mission is to maintain the command of the air over the battle zone and to support our side in maintaining or capturing the command of the air. Presently, the best carrier-based fighter has a maximum flying speed of 2,500 km/hr and an operating radius of 1,000-1,500 km. This type of plane is usually equipped with air-to-air and air-to-surface guided missiles and small-caliber cannons; can attack several targets simultaneously and is generally in the all-weather fighter class.

The carrier-based fighter bomber's primary mission is to attack enemy surface combatant vessels and other targets on sea and land. It is normally equipped with air-to-surface guided missiles, bombs, torpedoes, mines and a small-caliber cannon; its maximum bomb load can reach 8 tons and with the carrier as its base, the plane can carry out raids against land or sea targets within a 1,000 km radius.

The carrier-based antisubmarine aircraft's main mission is to search out and attack enemy submarines. It has good maneuverability and the capability of detecting and attacking submarine in a wide area and within a short time span. This class of aircraft is antisubmarine warfare's major weapon.

All carrier-based warplanes have the general characteristic of taking off and landing on a short runway, their wings can be folded and some of them, such as Britain's "Harrier" and Russia's YAK-36 can take off and land vertically. The British "Harrier" fighter was the earliest operational VTOL; its maximum speed is 1,100 km/hr (subsonic speed), maximum altitude is 15,000 m and it is equipped with air-to-air guided missiles, rockets and 30 mm cannons. This type of plane has a reversible turbofan jet engine (also known as roll-nozzle jet engine) with 8,620-9,752 kg of thrust. The engine's fore and aft sides have two pairs of roll-nozzles. The turbofan's air current and combustion hot air synchronously discharges from the nozzles at high velocity. Each pair of nozzles can be rotated from pointing backward to pointing straight downward or downward at a forward slant angle so that the engine's thrust can make the plane take off or land vertically or even to make the plane to go backward. The merits of this design are: the plane can take off or land on a short runway or a small flight deck and it has good maneuverability; its shortcomings are: the plane's operating radius is short and bomb load is less than other types of planes.

An aircraft carrier has a long cruising radius and huge cargo capacity. A certain type of carrier can stay in combat continuously for 15 days with each plane on board flying four sorties daily.

For self-defense, aircraft carriers are equipped with small caliber cannons, guided missiles, torpedoes, depth charges, etc. to attack targets on the surface, underwater and in air. All the above-mentioned weapons are installed or placed on both sides of a carrier to save space on the flight deck and to get a better angle for firing or launching.

### C. The Aircraft Carrier Is the Nucleus of a Fleet

The modern aircraft carrier has excellent combat capabilities and is frequently incorporated in an ocean-going fleet, becoming the nucleus of that fleet. An aircraft carrier fleet normally consists of one carrier, several cruisers, destroyers, frigates and submarines. This

kind of fleet possess powerful attacking force against target on surface (on water or ground), under water and in air. A carrier can sail 600 nautical miles (1,111 km) in 24 hours and carrier-based aircrafts' average operating radius can reach 1,000 km and therefore, an aircraft carrier fleet can reach an operation area of million sq km in 24 hours with a complete command of the area's sea and air.

The super powers, USA and Soviet Russia, are striving to construct and develop more aircraft carriers, especially nuclear powered carriers, to impose their hegemony over other nations in the world. There are 30 aircraft carriers in the world; the distribution is as follows:

|               |             |
|---------------|-------------|
| U.S.          | 14 carriers |
| Soviet Russia | 2           |
| Britain       | 5           |
| France        | 5           |
| Argentina     | 1           |
| India         | 1           |

U.S. and Soviet Russia have more than half of the world's aircraft carriers.

However, an aircraft carrier is not invincible; it has shortcomings also. Comparatively speaking, an aircraft carrier has a weaker defense against surface and underwater warships' attack. A carrier is a large target; consequently, it is vulnerable in an air raid. In the event that its flight deck is damaged or destroyed, a carrier loses its fighting power. Thus, an aircraft carrier cannot operate independently; it needs the protection from escorting warships.

#### 4. Cruiser, Destroyer and Frigate--the Main Strength in a Sea Battle

The cruiser, destroyer and frigate are the principal war machines in mobile surface warfare. They can destroy and chase away enemy warships; with naval air support, they can wrestle from the enemy and maintain the command of sea and can accomplish the missions of antisubmarine warfare, escort, supporting a landing operation or other combat duties. Because of their different functions, cruiser, destroyer and frigate have different sizes, weaponry and equipment. A cruiser is the larger ship; it displaces 5,000-20,000 tons, even up to 32,000 tons; can weather class 9-12 wind and wave; is equipped with more weapons and equipment and has better communication capability. A cruiser is the backbone of a fleet; its mission is to destroy and suppress shore targets; providing support in a landing operation, escorting a convoy, antisubmarine, etc. In case of there being no aircraft carrier in a fleet, the cruiser becomes its nucleus and flagship.

A destroyer is a medium size warship; it displaces 3,000-5,000 tons; is smaller in size than a cruiser; can weather class 8-10 wind and wave; has better firepower and cruising radius. During mobile warfare, the destroyer's mission is to destroy and/or chase away enemy combatant

vessels. A frigate is a small size warship, displaces 1,000-3,000 tons and has less weaponry and equipment. Its mission is to take up the duty of reconnaissance, security watch, antisubmarine and other escort chores on the fringe of a naval column and therefore, earned the name "security guard" of a fleet.

There are many similarities in ship's construction, weaponry and equipment between cruiser, destroyer and frigate. All of the three types of warships have the slender and pointed body with a raised bow, an awe-inspiring appearance. All three have multiple-deck construction and a superstructure on the top deck; their equipment includes weapons for anti-aircraft, antisurface vessel and antisubmarine use, such as guided missiles, torpedo, depth charges and artillery. Many cruisers, destroyers and frigates are also equipped with helicopters.

The performance of the modern cruiser, destroyer and frigate has been upgraded many fold in comparison with older types, especially in their fighting power. Modern cruisers, destroyers and frigates are all equipped with guided missiles and the majority of them have helicopters on board. The guided missiles, cannons, torpedos, mines, depth charges, helicopters and automatic command and control systems on board those warships form a multiple-purpose weapon system. This kind of weapon system greatly increased the warships' fighting power, i.e. the warships have short, medium and long range firepower to attack surface and underwater vessels, aircrafts and land targets.

Guided missiles are the cruiser, destroyer and frigate's primary weapon. The shipboard guided missiles are classified as ship-to-ship, ship-to-air and ship-to-submarine. The ship-to-ship guided missile has a longer range than the others, from several tens of kilometers to 600 km; an advanced type of ship-to-ship guided missile can skim several meters to 0.5 meter above the water's surface and hit its target at waterline to inflict a serious damage. The French made "Exocet" is an example of this type. During the Falkland War between Britain and Argentina, Argentina used Exocets to sink the British guided missile destroyer "Sheffield" and the chartered merchant marine "Atlantic Transport." Generally, a destroyer can be sunk or put out of commission by one or two guided missiles with a conventional warhead. The ship-to-air guided missile is similar to the army's ground-to-air guided missile; its range is normally under 100 km and it can reach an altitude of 20,000 m. The antisubmarine guided missile (also called torpedo with rocket booster) is actually a torpedo or depth charge with rocket propulsion. Upon the launching of an antisubmarine guided missile, the missile is propelled by its rocket to fly a pre-determined distance and then the missile enters water to attack its target by an acoustic guidance system. This type of missile can also be fitted with a nuclear warhead.

The antisubmarine torpedo can be steered both in the vertical and horizontal planes, i.e. the torpedo can change its direction of travel both up and down or left and right to track its target. Thus, this type of torpedo is also called a bi-plane homing torpedo. Currently, some countries are conducting research and developing new types of torpedoes to attack nuclear submarines. New types of torpedoes have a velocity of 50 knot/hr or even 70 knot/hr and can attack a submarine 900 meters underwater.

Naval guns are a warship's traditional weapons; they are still an effective short-range (within 30 km) weapon and are also being continuously improved. The majority of the modern naval guns are small-caliber, multiple-mounted, rapid-firing automatic cannons. A modern naval firing system consists of naval guns, fire-control radar, automatic train and elevation control system. This system can train the guns on a target, provide all the data for firing the guns automatically and has a fairly good degree of accuracy. The naval guns are primarily used to attack enemy surface vessels and aircraft, to intercept enemy aircraft or guided missiles, all nations are paying attention to make the guns into a small-caliber, quick-response, rapid-firing weapon system and to mount the guns in multiple-gun batteries. In the event of intercepting an incoming guided missile, all of the batteries fire a "projectile curtain" barrage to stop an incoming guided missile.

Most of the cruisers, destroyers and frigates are equipped with one or more helicopters that are used to carry out the antisubmarine operations of the ship or the fleet. A shipboard helicopter is usually a type of high-speed helicopter with good maneuverability, long operating radius and powerful antisubmarine capability. This type of helicopter is used for reconnaissance, antisubmarine warfare, attacking surface vessels, mine sweeping and also can be used to collect launching data for long-range ship-to-ship guided missiles.

A modern naval engagement is carried out simultaneously on water, underwater and in air, a very complex operation with myriad changes in an instant. To meet this challenge, the modernized cruiser, destroyer and frigate are equipped with automatic steering and control systems and a unified central command system to minimize any delay in action. In the event of an enemy attack, each component's response time can be shortened and the ship's fighting power as a whole increased.

##### 5. Sea-going Speedboats--Torpedo Boat, Guided Missile Boat

A speedboat is a type of light combat vessel; it is small but fast and can be called the "sprint champion" among combat vessels. Generally speaking, a combat vessel's speed does not exceed 35 knot/hr but a speedboat could reach a top speed of 40-60 knot/hr. Since a speedboat is small in size, fast in speed, has good mobility and maneuverability and is equipped with torpedoes and guided missiles, it is a powerful attacking weapon. A flotilla of speedboats is an effective assault force in coastal defensive warfare.

THE BASIC TACTICAL DATA AND FUNCTIONS OF CRUISER. DESTROYER AND FRIGATE

| Type of Warship  |   |   |  |
|--|---|---|--|
|  | CRUISER   | DESTROYER   | FRIGATE  |
| Data   |   |   |  |
| Item   |   |   |  |
| Full load displacement (ton)                           | 5,000-32,000  | 3,000-5,000   | 1,000-3,000  |
| Length (m)   | 160-240   | 120-160   | 80-120   |
| Width (m)  | 16-27   | 12-16   | 9-12   |
| Height (m)   | 40-60   | 30-40   | 30   |
| Draft  | 6-10  | 4-7   | 2-4  |
| Maximum Speed (knot/hr)                                | 30-35   | 35  | 30   |
| Cruising Radius (conventional power, in nautical mile) | 4,000-8,000   | 4,000-8,000   | 3,000-5,000  |
| Weapons on Board                                       | Antiship, antisubmarine, antiair guided missile; torpedo, depth charge, mine, cannon (203, 180, 127, 76.2, 57, 37 mm) | Antiship, antisubmarine, antiair guided missile; torpedo, depth charge, mine, cannon (130, 127, 100, 85, 76.2 mm) | Antiship, antisubmarine, antiair guided missile; torpedo, depth charge, mine, cannon (127, 100, 76.2 mm) |
| Helicopter on board                                    | 1-2   | 1 (not on every destroyer)  | 1 (not on every frigate)   |

Remarks

1. This table is a general description for the cruiser, destroyer and frigate. It does not refer to a particular ship. 2. Naval guns listed in this table are general descriptions for each category. Does not imply that all ships carry the same types or number of guns.



The advanced power plant and the structural design allow a speedboat to attain such a speed. Generally, its power plant is a high-speed diesel engine, a gas turbine engine or the combination of the two. Recently, another motive power, jet propulsion, has been used to propel a speedboat. In this system, the boat is not propelled by the turning of a screw but is pushed by the reaction of high-speed water jets on the boat's stern. The power plant turns a high pressure centrifugal pump, the pump gets the water from an intake port, builds up its pressure and then the water is pushed out through jets on the speedboat's stern at high speed. With this water jet propulsion, a speedboat can reach a maximum speed of 80 knot/hr.

The new hydrofoil can reach a high speed also. A hydrofoil is a boat which has a pair of airplane-wing like blades attached to its bottom; when the boat is moving forward at a fast speed, the blades create a lift and raise the boat out of water; consequently, water friction is reduced and the boat's speed is increased. Currently, a hydrofoil can reach 50 knot/hr.

There are two kinds of speedboat, i.e. the torpedo and guided missile speedboats. A torpedo boat is the smaller of the two; it displaces 10-200 tons and its main weapons are torpedoes for attacking surface vessels.

Depending on usage, the torpedo has two types; one is for attacking surface vessels while the other is for antisubmarine warfare. Both kinds can be launched by combat vessel or aircraft. The torpedo itself has motive power and an automatic control system. It can travel at a maximum speed of 50 knot/hr after being launched. An anti-surface vessel torpedo has an automatic directional control system; however, it can travel only at a pre-set depth level and therefore is also called the "one-plane self-navigation torpedo." An antisubmarine torpedo has a bi-plane automatic homing device which has been introduced in the proceeding section. A torpedo is detonated on impact or by a timing device; its range is several thousand to ten thousand meters, maximum 40,000 meters and its explosive charge is 90-200 kg or more. There is also the nuclear torpedo; for example the USA's MK 45 atomic torpedo has a demolition radius of 1,600 meters, about 100 times more powerful than a conventional type.

On 1 July 1950, the Korean People's Navy launched a surprise attack against the US Navy's invading cruiser fleet with four torpedo boats that sunk one heavy cruiser, the 13,000 ton "Chicago," and damaged one destroyer during that engagement. This was a very good example of the torpedo boat's prowess in a sea battle.

In the latter part of 1950, the guided missile speedboat appeared on the scene, this new development upgrading the speedboat's fighting power further. For example, the Israeli "Reshef" guided missile speedboat displaces 415 tons, has a speed of 32 knot/hr and is equipped

with four "Harpoon" guided missiles and five "Gabriel" guided missiles. The guided missile trajectory is 60 m high at the beginning of its flight, drops to 20 m, approaches its target at a 3 m high level and is very hard to defend against.

The shortcomings of a speedboat are its short range, dependency, coastal defensive ability and the fact that once it has spent its missiles, it has to return to its base to restock before the next battle.

## 6. Special Mission Combatant Vessels

In a modern sea battle, there are many specialized combat missions, such as antisubmarine warfare, torpedo warfare, amphibian operation, etc. To satisfy these mission requirements, a modern navy must have specialized combat vessels--submarine chaser, mine sweeper, mine layer, landing crafts, etc.

### A. Submarine Chaser, a Specialized Vessel for Attacking Submarine

Ever since the submarine's appearance in naval combat and its increasing menace to fleet or sea transportation, antisubmarine warfare has become a very critical task. For this reason, all cruisers, destroyers and other combat vessels are equipped with antisubmarine weapons. In practice, to depend solely on surface combat vessels' antisubmarine measures is not enough; one must have specially equipped submarine chasers to use special measures and tactics to detect and destroy enemy submarines and therefore, a submarine chaser is also called the "hunter on the high seas."

A submarine chaser's mission is to attack submarines; it displaces between 80-500 tons and usually has a speed of 20-60 knot/hr. It is fast and has good maneuverability, so that it can move freely to track submerged submarines. If a submarine chaser is bigger than 500 tons, it is usually carrying more weapons than smaller ones.

Submarine chasers depend on sonar to detect a submerged submarine. The so-called sonar is an instrument which uses the theory of sound waves transmitted by sea water (about 1,500 m/sec) to detect the presence and location of a submerged object.

Depending on methods of operation, sonar can be classified into active and passive types. An active sonar can send out sonic waves and receive the bounced back wave from a target to determine its location. A passive sonar cannot send out sonic waves but can receive sonic waves or noise from a target to determine its location. A modern sonar's operational range can reach 30 nautical miles. The older type sonar sends out sonic waves rhythmically (sending out a sonic wave, waiting for its echo and then sending out another wave); the improved sonar can send out sonic waves continuously and can be operated like

an electronic scanning instrument. Furthermore, it can send out and receive sonic waves on multiple wave bands which improves the speed of detection. A submarine chaser has its sonar in the bow. There is a tow-type sonar which can be towed by vessel or antisubmarine helicopter.

Upon the detection of a target, a submarine chaser uses antisubmarine torpedoes or depth charges to destroy it. The antisubmarine torpedo has been discussed in the preceeding section. There are many kinds of depth charges; smaller types have several tens of kilograms of explosives and larger ones can have more than 200 kg of explosives. Presently, there is a kind of nuclear depth charge; its destructive power is the equivalent of 10,000-20,000 ton of TNT; its demolition radius is 2.5 km in contrast to a conventional depth charge of 250 kg class which has a demolition radius of 10 meters only when detonated under 10 m of water. A depth charge is pre-set to detonate at a certain depth depending on the location of a target. Depth charges can be launched from multiple-mounted rocket launchers, by multiple-mounted depth charge throwers or by rolling off from a frame; conventional depth charges are normally launched in a barrage of 10 or more to insure effectiveness. All combat vessels and aircraft that have antisubmarine capability can be equipped with antisubmarine torpedoes and depth charges.

#### B. Minelayer and Mine Sweeper

The mine layer and mine sweeper are vital elements in naval mine warfare. A minelayer is an "expert" in setting up a minefield while the mine sweeper is a "vanguard" in clearing mines from the sea. The combat strength of minelayers and sweepers is closely related to the type and function of the mines that are being handled by the warships and therefore, in order to understand the characteristics and capabilities of the minelayer and sweeper, we must discuss the naval mine first.

(1) A naval mine is an underwater land mine and is very destructive; it can sink a large ship, blockade a naval base or harbor and sever sea lanes. Naval mines have achieved prominent results in naval warfare. In WWI, a total of 310,000 mines were used by all combatants and the mines sunk 148 surface combatant vessels, 54 submarines and 586 merchant marines. In WWII, mine warfare was expanded further; a total of 800,000 mines were used to sink 2,705 combatant vessels. USA and Britain laid 12,000 naval mines to set up a blockade against Japan; the mines sunk or damaged 1,400,000 tons of Japanese combat vessels and merchant marine ships or 3/4 of Japan's total tonnage; severed the sea lane between Japan and its island bases in the Pacific Ocean and paralyzed nationwide water transportation in Japan. Naval mines are being improved further and will become more effective in the future.

Based on methods of laying, naval mines can be classified as floating mine, moored mine (using anchor and anchor chain to hold the mine submerged), ground mine and new types of ground mine which can automatically float up and track a target. This type of weapon is actually the combination of torpedo and mine.

Naval mines can be classified according to their mode of detonation, i.e. contact and influence mines. A contact mine is detonated when its contact horns are hit by a ship. There are three types of contact mines depending on the amount of explosive in them: large size--250 kg, medium size--120 kg and small size--20 kg. An influence mine needs not to have physical contact with an object to detonate it; its firing mechanism is actuated by magnetic field, acoustic effect or by variation of water pressure. There are several kinds of influence mine, i.e. magnetic mine, acoustic (sonic or ultrasonic) mine, pressure mine and combination-fuze mine. A large influence mine has 700 kg of explosives and a small one has 300 kg. There are also nuclear mines whose power is about the same as a nuclear torpedo or depth charge. Naval mines can be concealed well and can be operational for a long period of time. Once a minefield is set up, it would be a serious threat to enemy shipping.

## (2) Minelayer--An Expert in Setting up a Mine Field

A minelayer's primary mission is to set up a mine field in water; it displaces 2,000-3,000 tons and can carry about 400 mines. In order to insure a mine's effectiveness, the mines should be laid at certain intervals and in the sea lane that enemy vessels must use. Also, the depth of a submerged mine is critical; too deep, and enemy vessels won't contact with mine; too shallow, and it would be easily discovered by the enemy. Normally, a mine should be laid at a depth of  $\frac{3}{4}$  of the enemy vessels' draft.

Method of laying naval mines: (a) determine the depth of a submerged mine in accordance with combat requirements; (b) adjust the depth control mechanism in each mine; (c) large or medium size mines are laid by minelayer; (d) small size mines can be laid by rocket. After the mines have been dropped into the water, the floating mines will float at a pre-determined depth; moored mines will be moored at a pre-set depth; ground mines will sink to the sea bottom. A minelaying rocket can carry 6-8 small mines in a compartment in front of the rocket engine; after the mine-carrying rocket is launched and before it hits the water, the mine compartment will be opened automatically and the mines will fall into the water to form a minefield. All types of aircraft, combat vessels, even fishing boats, freighters and shore units that have minelaying equipment can carry out mine laying operations.

In accordance with a minefield's objective, it can be classified as either a defensive measure or an offensive measure. For instance, laying mines in front of shore positions and coastal area to resist enemy landing operations is a defensive measure, while laying mines to seal enemy naval bases, harbors and waterways to restrict the enemy forces' mobility and interrupting the enemy lines of transportation is an offensive measure. All mine laying operations should be carefully planned, carried out without error and in secrecy to avoid self-destruction or discovery by enemy.

### (3) Mine Sweeper--the "Vanguard" in Clearing a Minefield.

A mine sweeper has the equipment to clear different kinds of mine; when clearing moored contact mines, the mine sweeper has the equipment to cut the mine's mooring line. The released mines float to the surface and are disposed of. When sweeping magnetic mines, the sweeper can produce a powerful electro-magnetic field to detonate the magnetic mines at a safe distance away from the sweeper. When sweeping acoustic mines, the mine sweeper produces a sonic wave to detonate the mines at a safe distance away from the sweeper.

A mine sweeping ship's displacement is about 500-1,000 tons or more; a mine sweeping boat displaces only 60-500 tons. For self-defense, a mine sweeper is also equipped with small-caliber cannons and depth charges. Presently there is a crewless remote-controlled mine sweeper in use which is steered and controlled by radio signal. This type of sweeper is equipped with magnetic coils around the hull and a sonic wave generator. It can sweep magnetic and acoustic mines or mines with magnetic-sonic combination fuzes.

Another kind of vessel in naval mine warfare is called the "mine hunter"; both the vessel and equipment on board are completely nonmagnetic or very slightly magnetic. The vessel is equipped with wire rope, mine locator and mine disposal. The mine disposal is a modern mine sweeping tool which is actually a remote-controlled underwater craft; it has underwater TV and other equipment on board and can move around underwater about 2 meters above sea bottom to search out, identify and destroy or pick up enemy mines.

There are other means to sweep mines, such as dropping depth charges to detonate each mine; this method is used to clear a vital navigation route.

### C. The Modern Landing Craft & Ship

A landing operation is a specialized offensive action; however, it has been a form of combat since ancient time. In the past, an invading army depended on regular combat vessels to transport its troops to their destination and could only land its troops at locations where there were harbors with piers and other port facilities, but those

locations were well defended by the adversary and therefore, the landing operation was very difficult to execute. A good example to illustrate this problem is the British-Franco Combined Force's landing campaign at Gallipoli Peninsula on the west side of the Dardanelles Strait in April 1915 during WWI. This campaign lasted 14 months and mobilized several hundreds thousand troops, but the combined force was badly mauled by the Turkish Force and retrated. Although lack of proper landing vessels was not the only cause for the British-Franco Force's defeat, it was a major factor.

Following the progress of military science and technology and in order to meet the requirements of amphibious warfare, specially designed landing craft andships were developed. Those vessels have the general characteristics of flat bottom, shallow draft, large cargo capacity design and have the capability fo approaching a gentle shore or beach-head without port or dock facility. The landing craft or ship can transport infantry, artillery, armored forces and many other kinds of vehicles; it has good capability in sea navigation and is well equipped for amphibious operation. During WWII, all nations hurriedly contructed many kinds of landing crafts and ships and amphibious combat vehicles, i.e. amphibious tanks, armored vehicles, etc., to carry out landing operations at wide areas and to expedite the expansion of an occupied beachhead. A survey indicated that there were more than 600 landing operations of different scope during WWII and most of the operations were successful. One can see easily that having good landing crafts and ships are the prerequisite of a smooth and successful landing operation.

Modern landing craft and ship have many types and models; mainly, there are landing ships, landing crafts, landing ship docks, amphibious assault ships and many other kinds to meet the needs of a landing operation.

- (1) The landing ship is a combat vessel for transporting and landing troops, tanks and amphibious combat vehicles directly in a war zone. There are two types of this class of vessel:
  - (a) the large landing ship displaces 3,000-8,000 tons, can carry 20-40 tanks or a fully equipped marine battalion and its equipment and supplies;
  - (b) the medium landing ship is under 3,000 tons or over 500 tons. It can carry 5-12 tanks or an infantry battalion. The ship is equipped with naval guns and other weapons for self defense.

A landing ship usually has a large hold for personnel and supplies. Some modern landing ships have one ship-length large hold and built-in ramps in the bow and stern. When beached, the forward ramp is lowered to facilitate the discharge of men and vehicles. Landing craft andship are shallow draft roll-on and roll-off vessels that can be beached under favorable hydrographic conditions.

(2) The landing craft is a small type of landing vessel for troops; it displaces 25-500 tons, can carry a platoon and up to a company of infantry or several tanks and has a speed of 10-15 knot/hr. In a short distance, it can ferry troops from an embarkation point directly to a beachhead to launch an assault. For a long distance haul, landing crafts are carried by a landing ship dock to a certain distance from the beachhead and launched from the dock ship to head for the beachhead. Because of its agile mobility and shallow draft, a landing craft is adept at beach landing.

Presently, there is another kind of landing craft which can "fly" close to the water's surface--the hovercraft, a new piece of equipment for landing operations. A hovercraft has a skirt made of elastic material around the lower part of the craft and is equipped with several turboprop power plants. The turboprops produce a flow of air into the skirt which causes a rise in air pressure. This air pressure becomes a lifting force to raise the craft above the water surface (or ground) while the turboprops' jet propulsion pushes the craft forward at the same time. This type of craft is also called an air-cushion craft. Among the existing landing hovercrafts, small ones can carry an infantry squad or two tons of supplies; medium-size hovercrafts can carry one infantry platoon or 3-10 ton of supplies and large-size hovercrafts can carry several hundred troops or 1-2 tanks or 80-90 tons of supplies. This type of landing craft has a speed of 60-70 knot/hr, a cruising radius of 170-500 nautical miles and is equipped with small-caliber cannons for self-defense. A hovercraft's principal merits are fast speed and landing by "flying in." Tactically speaking, it has the following advantages: (a) it can transport personnel and supplies directly to the land from a shore with gentle slope and a very wide beach; it would be very hard for an ordinary landing craft to accomplish this; (b) it can avoid damages inflicted by naval and land mines; (c) it can execute a fast landing and thrust deep into the enemy position to disrupt their defense deployment.

(3) The landing craft dock is a sea-going floating dock; its principal mission is to ferry landing crafts, amphibious combat vehicles and combat units to the landing zone. The rear half of a landing ship dock is usually a small dock to accommodate the landing craft and amphibious combat vehicle's entry and exit. This type of landing ship displaces about 13,000 tons; has a speed of 20 knot/hr or better, loading capacity of 20 landing crafts, 4-6 helicopters and a battalion of fully-equipped troops. During a landing operation, a landing ship dock does not physically participate in landing; it stops on the sea not too far away from the landing zone and lets the landing crafts or helicopters ferry the troops onto the beach.

(4) An amphibious assault ship is a large size landing ship that displaces 20,000-40,000 tons, has a speed of 20-25 knot/hr, carries 30 or more helicopters, many landing crafts and 500-2,000 marines. Its armament includes many 127 mm, 76.2 mm and smaller caliber cannons, ship-to-air guided missiles, antisubmarine guided missiles, etc. It has relatively strong offensive firepower. Upon its arrival in the vicinity of a landing zone, its on-board helicopters or landing crafts can ferry the troops to land and assault the enemy position. Some of these types of landing ships were converted from antisubmarine light aircraft carriers, but many were newly built.

## 7. Coastal Artillery and Shore-to-ship Guided Missile

Naval combat vessels' operational area is on the highseas, but they need naval bases and harbors along the coast for logistic support, so therefore, one of a navy's combat operations is to defend the bases and harbors. Coastal artillery and the shore-to-ship guided missile are the major components of a navy's coastal defense firepower. Their mission is to attack enemy warships and transports when they come within range. Coastal artillery proved to be very effective in carrying out its mission in the past. During WWII, Germany's landing operation at Oslo, Norway on 9 April 1940 was not successful; of the three German cruisers in that landing operation, one was sunk and another was damaged by coastal guns and torpedoes. In the end, Germany captured Oslo by using airborne troops. Nowadays, coastal defense forces are equipped with shore-to-ship guided missiles which have a longer range than artillery, are more accurate and more powerful. In the future, coastal defense will play a more important role than before.

### A. Coastal Artillery

The primary targets of coastal artillery are enemy surface combat vessels. However, they can be used to shoot shore targets also. The gun's construction and technical data are basically the same as ship-based guns. The coastal guns are usually deployed in fortified permanent defense positions (there are mobile coastal guns also); the guns are equipped with fire control and are relatively more accurate and powerful. Coastal artillery's maximum range can reach 40 km; its projectile weighs from 20 to 800 kg; rate of firing is about 5-20 round/min. An average of 20 rounds from a 180 mm gun can sink a large warship such as a cruiser and 5 rounds can sink a medium-size warship.

B. Shore-to-ship guided missiles are tactical missiles of the cruising type. Since they became operational, the power of coastal defense has been greatly upgraded and it will be the key point in developing better weapons for coastal defense. This type of missile has the following strong points both in defensive and offensive usage: long range, accuracy, high velocity and power. Its range is 40-300 km and



some types can reach 450 km with mid-range course correction by an airplane. There are conventional and nuclear warheads for the missiles and their accuracy is 70-80%. Based on calculations, 5-7 rounds of conventional warhead missiles can sink an aircraft carrier or cruiser and 2-3 missiles can sink a destroyer or a 10,000 ton class merchant marine. This type of guided missile can be launched from concealed fortifications or from mobile launchers.

#### 8. Security Measures for Modern Naval Battles

Modern naval engagement is a confrontation of different arms between two hostile navies on water, underwater and in air; all of the combat actions are coordinated and executed simultaneously in a wide area with lightning speed. The weapons used in modern warfare are powerful; battles are complex and war situations change rapidly and instantaneously, therefore, modern naval warfare requires a higher degree of security precautions. The lack of an organized security system and capability is detrimental to combat units' action and the victory of a sea battle.

Due to the new changes in naval weaponry, equipment and tactics, combat security acquired new facets that are "broad," "varied," "numerous," "rapid" and "precise." The word "broad" is used to describe how wide a space the security has to cover because modern warfare encompasses actions on water surface, underwater and in the air. "Various" indicates fast changes in military strength on both sides and in nature (oceanography, hydrology, meteorology and weather condition). "Numerous" describes scopes to be covered by security measures, i.e. reconnaissance, observation, communication, electronic warfare, anti-nuclear, chemical and biological warfare; camouflage, engineering, ocean and air navigation, hydrology, meteorology, safety, rescue, etc. "Rapid" and "precise" means that all of the security measures should be carried out instantly, precisely and on time.

In carrying out reconnaissance, observation and protection missions on the highseas, the navy's electronic signal monitoring ships, radar picket destroyers, early warning airplanes, antisubmarine patrol planes and vessels, shore sonar stations, shore monitoring stations and all of the technical reconnaissance units are organized into a multiple-purpose detection network and security force to continuously monitor the war situation and military strength of both sides, on the water, underwater and in the air in order to insure the security of our forces in combat action.

In order to provide the navy with unimpeded communication and to be under effective command throughout its operations on the highseas, the modern navy is equipped with many types of and operates many channels of communication network. However, to communicate with a submerged submarine, the navy must depend on long wave or ELF communication only. In addition, the navy also has communication ships to insure good communications on the highseas and communication cable laying ship to lay, repair and retrieve cables.

In order to have safe and correct navigation, the navy has many specialized navigation radio stations on shore and in satellite. The different navigation installations form a coordinated system to guide naval vessels to sail on a planned course under all kinds of weather, hydrological and meteorological conditions and to insure that the vessels carry out combat missions without a hitch.

Navigation security is a very critical measure in a navy's operation; the naval force's safety and the outcome of a battle depends on navigation security. Components of this service and combat units must be constantly and timely aware of changes in an operation area's geographic, hydrological and meteorological conditions and must know the situation of their sea route. To accomplish its mission, the navy is equipped with oceanological survey ships, navigation marker ships, weather satellites and radar stations, weather observation stations on planes and vessels and many other kinds of systems to observe and detect meteorological changes.

In addition, the navy is also equipped with specially designed contamination inspection and decontamination ships to be used in nuclear, chemical and biological warfare and life rafts and rescue boats for safety and rescue operation.

Presently, the reconstruction of the navy as well as other branches of service is aiming to achieve a higher degree of modernization. Due to the differences in social systems, geographic locations, economies and military strategies, each maritime nation's objectives, policies and extent of navy construction is different. In struggling for world domination, the two super powers, the USA and Soviet Russia, are aggressively constructing powerful ocean-going navies and devoting their major efforts to develop the strategic guided missile equipped nuclear-powered submarines, nuclear-powered aircraft carriers, nuclear-powered attack submarines and other ocean-going guided missile vessels. They are now in the stage of deploying medium-and long-range cruise missiles to expand their nuclear striking power. In the meantime, the two superpowers are developing new types of landing craft and ships and organizing new marine units. In order to upgrade their world-wide roving naval forces' quick response capability, both the USA and Russia are deploying ocean surveillance satellite systems, so that they can command their naval force's combat action on time and on location without delay. On the other hand, the Third World nations are constructing coastal navies that are capable of defending their coast and fighting off invaders.

Our great fatherland has a wide and long coast line of more than 18,000 km, extending from the Yalu River in the North to the Beilun River mouth in the South. Our territorial seas include the Yellow Sea, East Sea, South Sea and vast inland seas. Our territorial islands and isles are as numerous as stars in the Milky Way; there are more than 6,500 islands

with a land area over 500 sq. m. For the sake of defending the coast line of our socialist fatherland and world peace, we must build up and modernize our large army and air force and simultaneously, we must have a powerful and modern people's navy.

## Chapter VI: MODERNIZED AIR FORCES

### 1. Composition and Mission of a Modern Air Force

A modern air force is an important armed force and is indispensable for waging three-dimensional warfare. Many countries evaluate the position of an air force in a future war extremely high, maintaining that a modernized war will be fought and won jointly by the army, navy, and air force and that without an air force it cannot be won.

In comparison with the army and the navy, the air force is a comparatively young service, and for a very long time the combat aircraft of many countries were subordinate to their armies. In 1918 Britain was the first country to establish an air force. In 1946 the Soviet Union formed an independent air force. In 1947 America established the system of three component services: army, navy, and air force. As of now, the great majority of countries that possess considerable military strength have established air forces. In the world there are about 97 countries and blocs that have combat aircraft, and among them 31 have 200 or more of these aircraft.

A modern air force is a comprehensive combat system composed of many commands, units, and organizations, divided into arms or commands according to their different missions. For example, the Soviet Air Force is divided into the arms of Long-Range Aviation, Frontal Aviation, and Military Transport Aviation. The U.S. Air Force is divided into the Strategic Bomber Command, Tactical Air Command, Intercontinental Ballistic Missile Command, Military Airlift Command, and the National Warning Command and Territorial Air Defense Command. Britain's Royal Air Force is divided into three commands under three separate headquarters. The first is the Air Force Command, West Germany, which commands the British Air Force units stationed in that country; the second is the Strike Command, which has under its command all the air force units in Britain proper; and the third is the Support Command, which is responsible for all logistics support. Our country's air force is composed of the air arm, antiaircraft artillery arm, radar arm, communications arm, and surface-to-air guided missile units. Only five countries--the Soviet Union, Vietnam, Romania, Poland, and Algeria--have set up an independent air-defense force outside their air force.

The organizational structure of a modern air force is quite complex. First, there is a command system and an integrated nationwide (for some countries it

is even worldwide) communication net, which are responsible for effecting unified command and liaison. Next, radar stations must be set up in important areas throughout a country, forming a tight antiaircraft warning net to guard against sudden raids by an enemy. A navigation or global navigation system must be set up to guide aircraft and prevent them from drifting off course in cloud and mist or at night. A nationwide meteorological network must be set up to insure flight safety.

The structure and equipment of modern aircraft are complex. Every aircraft requires various kinds of technicians to maintain it, so there must be set up in the air force units a huge contingent of ground crew maintenance personnel. In addition, an air force must have a huge logistics support contingent and a huge scientific research contingent.

An air force's missions are determined by the requirements of warfare. A modern war often begins with an air raid, and therefore there are now two basic missions for the air forces of all countries: 1) when there is a need to mount a sudden attack on the other side, the air force has the mission of making the first attack; and 2) the air force has the mission of being on guard at all times against a sudden attack by the other side, so as to insure the security of the country's territorial airspace and its important installations. Specifically, during a war the air force is charged with the missions of making surprise attacks and countering surprise attacks, directly supporting the offensive and defensive operations of the ground forces, supporting the navy and the army in making landings from the sea and resisting landings from the sea, wiping out enemy air-landed troops and supporting the operations of the air-landed units of its own side, and coordinating with the army and the navy in completing campaign and battle missions; during the course of a war, it is charged with the mission of destroying or damaging important targets and communication and transportation lines in the enemy's rear; it is charged with the mission of making airlifts, airdrops, and air rescues; and it is charged with the mission of making aerial reconnaissance and carrying out electronic countermeasures.

All the various kinds of missions that a modern air force is charged with are completed by many types of aircraft. The principal types of aircraft in a modern air force are: fighter plane, bomber, attack plane, reconnaissance plane, transport plane, inflight refueling plane, helicopter, early warning plane, as well as command plane, electronic jamming plane, and pilotless reconnaissance plane. Following is a detailed introduction to the separate types.

## 2. Powerful Modern Combat Aircraft

### A. Types of Combat Aircraft

Originally there was only one type of combat plane which was used both for reconnaissance and for bombing (hand-thrown mortar shells) and fighting. In the World War I period, there was a big increase in the types of aircraft with the emergence of single-seater fighters, two-seater reconnaissance planes, and large bombers. By the time of World War II, there were even more types of aircraft, roughly divided into two main categories: One category comprised

aircraft fitted with weapons, like fighter planes [zhandouji 2069 2435 2894] (in our country called fighter planes [jianjiji 3005 2345 2894]), bombers, and attack planes. The other category comprised aircraft that did not have weapons or only had weapons for self-defense, like transport planes, reconnaissance planes, and trainers, none of them counting as combat aircraft. Up to the present time, combat and noncombat aircraft are differentiated in accordance with this concept. In the middle of the 1950's, there appeared a new type of aircraft that could both fight and bomb--the fighter-bomber--and in the 1960's there appeared the armed helicopter, both falling into the category of combat aircraft. Then, early in the 1980's, the space plane, or space shuttle, appeared. Strictly speaking, the space shuttle is not an aircraft but a manned spacecraft that goes into space and then returns to earth and that can be used repeatedly. Like a rocket it takes off vertically, like a satellite it orbits the earth, and like an aircraft it lands levelly on a runway. The space shuttle is composed of three main parts: orbiter, booster, and external storage hold. The orbiter is the main body of the space shuttle and is similar to a large airliner with a delta wing. The booster is composed of two fixed rockets. In the external storage hold is stored the propellant used by the orbiter's engine. The space shuttle can carry various kinds of communication, navigation, and early-warning equipment. It can carry reconnaissance satellites into space or return them to earth, and can also inspect and perform maintenance on them in space. In addition, it can perform the missions of military reconnaissance, anti-enemy satellite measures, and strategic bombing.

The performance of modern combat aircraft is good. Separately they can fly at high altitudes and high speeds, fly for long ranges, fly in all kinds of weather, and carry heavy loads; they can be put on automatic pilot and automatic control, can penetrate defenses at minimum altitude, can take electronic countermeasures, and can take off and land in different patterns. Because there has been a very big improvement in the performance of modern combat aircraft, their combat capability is also markedly improved over that of combat aircraft in the World War II period. They possess both the capability for rapid mobility and long-range operations and the capability for many patterns of attack and very strong attacks.

Under conditions of modern warfare, noncombat aircraft have been strategically refitted and have been equipped with some weapons so that they can be turned into combat aircraft. A basic viewpoint of all modern air defense is that after enemy aircraft are discovered they are all regarded as combat aircraft, and preparations are made for air-defense operations to prevent sudden attacks by the enemy.

#### B. Main Force in Aerial Combat--the Fighter

A small (relatively speaking) combat aircraft specially used for aerial combat is called a fighter plane. This aircraft plays a major role in contending for air superiority and is the most important kind of aircraft in a modern air force. Fighters constitute a very large proportion of the equipment of the air forces of all countries, and are indispensable to modernized national defense. Modern fighters are somewhat bigger and heavier than those of the past. The usual length is 17 to 18 meters with a wing span of 12 to 13 meters; the

weight is 7 to 10 tons, with a large fighter weighing 18 to 22 tons, and some individual fighters weighing 36 tons. A modern fighter is fitted with many kinds of weapons and equipment. For example, America's F-15 fighter has two large-thrust jet engines, one 20mm six-barrel swiveling gun that fires 6,000 rounds a minute, four "Sparrow" medium-range air-to-air missiles, and four "Sidewinder" close-range air-to-air heat seeking missiles; its maximum payload is 5,440 kilograms. Precisely because more and more weapons and equipment are being put on an aircraft, its price becomes more and more expensive. In the 1950's, a fighter cost about \$1 million, but by 1981 the price of one U.S. F-15 fighter was \$27.9 million. To maintain a fairly strong air force, many countries in the world pay out huge sums in military expenditure.

Since the beginning of the 1970's, jet technology, electronic technology, and missiles have been widely applied to modern fighters, whose capabilities for mobility and attack have been raised to a completely new stage.

(1) Good Mobility. A fighter's mobility mainly includes four aspects: flying speed, climbing performance, level flight acceleration performance, and circling performance. The principal performances of modern fighters are greatly improved over those of aircraft in the past.

The maximum level flying speed of a modern fighter has been developed to more than 3,000 kilometers per hour, about three times the speed of sound, from the 500 to 600 kilometers per hour of fighters in World War II. But when the aircraft is flying at low altitude its speed is not that fast. Because the atmosphere at low altitudes is dense, if the aircraft flies too fast it will suffer a big drag from the atmosphere and its airframe will be unable to sustain the strain. Therefore, the maximum speed now of a fighter at low altitude is 1,300 to 1,400 kilometers per hour (360 to 390 meters per second), slightly exceeding the speed of sound. The fast speed of an aircraft makes it easy for it to pursue and attack enemy aircraft or shake off enemy aircraft, and when flying at low altitude it is not easily hit by ground artillery fire.

The climbing performance of a modern fighter is particularly strong and its acceleration is fast. In World War II, the climbing rate of aircraft was only 18 to 80 meters per second. The maximum climbing rate of a modern aircraft has reached 320 meters per second, and it takes only 3 minutes to ascend from sea-level to the high altitude of 20,000 meters. It has reached a high degree in level acceleration performance, requiring only a little over 2 minutes to accelerate from 900 to 2,000 kilometers per hour. In aerial combat, the aircraft with good climbing ability and fast acceleration will take precedence in occupying a high position and swiftly going on the attack, and it will have the initiative. Because the speed of a modern fighter is very fast, generally speaking, its circling performance is poorer than the aircraft of the past. But, judged overall, the military performance of a modern fighter is incomparably better than that of aircraft of the past. There are many reasons for the good mobility of modern fighters, but the most fundamental one is that they have jet engines. In the past the engine used in an aircraft was similar to the one used in a car, both being piston engines. After the engine was switched on, it turned a propeller, which produced an air stream blowing to the rear and pulling the aircraft forward. A jet engine is completely

different from a piston engine. It omits the propeller and sucks air directly into the engine, where the air is sprayed with fuel and burned, after which the high-temperature compressed airstream spurts to the rear producing the thrust that causes the aircraft to move forward at high speed. Its characteristic is a large thrust; also, the thrust it produces is able to increase the flying speed as it is increased. Therefore, the appearance of the jet engine ushered in a new era in the history of aviation.

(2) Strong Attack Capability. There has been an extremely great improvement in the attack capability of the modern fighter. The main reason for this improvement is that in its attack weapons there has been a switch from making small cannons primary to making air-to-air missiles primary. There is now a large assortment of air-to-air missiles carried by the fighters, and their performance is good; with the aircraft's fire control system with the electronic computer as its center, a system which performs excellently, the modern fighter possesses an attack performance that is "all-directional, all-altitude, all-weather, multitarget, and multirange."

In the past the fighter's main weapon in aerial combat was the machine cannon (also called the aircraft cannon). The machine cannon's effective range was less than 1,000 meters, its best firing range was 600 meters, and its best firing position was behind the tail of the target aircraft. Therefore, in aerial combat, in order to shoot down the other side's aircraft an aircraft had to find a way to circle behind it, swiftly approach it, and get close enough to fire. The fighter of that time had an attack capability only under weather conditions in which the fighter's pilot could see the other side's aircraft, in one direction (the target aircraft's rear), at one altitude (basically the same altitude as the target aircraft), at one target (the target aircraft), and at one range (close range).

In the modern fighter, the use of air-to-air missiles is made primary. The closest range at which the missile can be used is 500 meters and the longest 140,000 meters; the lowest altitude that it can be used is several dozen meters and the highest 24,000 meters. The flying speed of an air-to-air missile is very fast, between 2 and 5 times the speed of sound, and it has several ways of tracking its target. One way is to track by means of the radiation of infrared rays, and this kind of missile depends on the infrared radiation rays emitted by a jet engine to hit its target. Another way is radar tracking, in which radar on the aircraft sends out electromagnetic waves that illuminate the target, and the missile tracks the target by means of the radar waves reflected by the target. Still another way is radio tracking, in which the missile's flight toward the target is directed by radio commands sent by the aircraft's pilot. Also recently being developed is an air-to-air missile that is controlled and guided by laser. The modern aircraft is equipped with a fire-control system that is responsible for the work of aiming, firing, and guiding its missiles (including the aiming and firing of its guns). An advanced fire-control system is principally composed of a radar or infrared instrument, an electronic computer, and control and display components. It can detect, track, compute, and aim at many targets at various altitudes (particularly at low altitude) and various ranges, and can control a simultaneous attack by several missiles on several scattered targets. Therefore, there has been an extremely great improvement in the combat



capability of the modern fighter. It has the capability for attacking in all directions (from the front, flank, and rear of the target aircraft), at all altitudes (target aircraft at all altitudes, particularly at low altitude), in all weather (day, night, clear, cloudy), at many targets (multi-target aircraft), and at various ranges (close, medium, and long). When a fighter is attacking, its pilot need not see the other side's aircraft, and even less does he need to fly to a position behind its tail, because the radar aboard the fighter can search for the other side's aircraft within a range of 100 to 200 kilometers. After the radar discovers a target, the firing target completes a series of actions in which it detects, computes, and aims, and when the aircraft reaches a favorable firing position, the firing system sends a signal to the pilot, who presses the firing button which automatically fires the missile toward the target.

There has also been a very big development in the performance of the machine cannon carried by modern fighters. For example, the maximum firing rate of the 20mm six-barrel swivel gun is 6,000 rounds per minute. With many shells hitting the target within this unit of time, the possibility of shooting down or damaging an aircraft is greatly increased.

The modern fighter's bomb-carrying capacity is also very large, and this is because of the large thrust of its engine. If it does not fly at supersonic speed, the engine thrust will have a very large additional capacity, so that 2 to 3 tons of bombs may be externally suspended from the fighter. This kind of fighter becomes a bomber and is called a fighter-bomber.

#### C. Long-Range Attack Weapon--the Bomber

In the 1950's there were many kinds of bombers, divided into long-range, medium-range, and short-range. The short-range bomber, also called the light bomber, was widely used in the 1960's, but following the gradual development of the fighter-bomber it has now fallen into disuse. The medium-range bomber can be refueled in the air, and its operating range approaches that of the long-range bomber. Therefore, almost all the bombers with which the air forces of modern countries are equipped with are long-range bombers. The long-range bomber is usually used to carry out strategic missions, namely, bombing the other side's political and economic centers and its important munitions industry bases. Beginning in the 1960's, there arose an international dispute over whether, because of the development of the intercontinental missile and the long-range missile, it was still worthwhile to develop the long-range bomber. Some people maintained: The long-range surface-to-surface guided missile can replace the bomber; the missile's cost is low, its maintenance is simple, and there is no need to train pilots for it. Other people maintained: The bomber is more flexible in response and use than the missile, it can stand by to fly at all times, and it is not easy for the other side to destroy it. The two viewpoints are argued endlessly. In the world now, only America and the Soviet Union are still researching and developing this kind of aircraft, but the pace of this research and development is very slow. The bombers that America and the Soviet Union now have are basically the products of the 1950's and 1960's. For the most part their flying speed is subsonic, being about 700 to 800 kilometers per hour, and their combat radius is 4,000 kilometers or even a little longer. but the bomb-carrying capacity of these aircraft is

quite large. Take, for example, America's B-52. Its length is 49.5 meters, its wing span is 56.4 meters, and its maximum bomb load is 30 tons.

Then, is it true that there has been no development of the old-type long-range bombers since the beginning of the 1970's? No! The prominent changes in the old-type long-range bombers are manifested in three aspects.

(1) Throwing New-Type "Smart" Bombs. In the past, bombers mainly used ordinary bombs. The bombing accuracy of these bombs was fairly low, the average error even exceeding 100 meters. In the late 1960's, there appeared a new-type bomb, called the "Smart" bomb. This bomb is similar in appearance to a conventional bomb. The difference is that it is equipped with a guidance system and a control rudder, and the bomb is controlled during its flight toward the target. In accordance with the principles of control and guidance, the "smart" bomb can be divided into two types. One type is the laser-guided bomb. Personnel in aircraft or concealed on the ground use a laser illuminator to illuminate the target, and the bomb tracks and hits the target by relying on the scattered laser signals that it receives as they are reflected back to it. The other type is the television-guided bomb. A television camera is fitted onto the nose of the bomb. The pilot aims the camera at the target so that an image of it appears on the television screen, then gets a "fix" on it and drops the bomb. If the bomb is a little off target, the guidance system immediately makes a correction that causes the bomb to home on the target. There has been an extremely great improvement in the target-hitting accuracy of the "smart bomb," the average error now being less than 10 meters and the smallest error being 3 to 4 meters.

(2) Use of Air-to-Surface Missiles. There are many ways to control and guide the air-to-surface missiles carried by modern bombers, namely, by radio, infrared rays, laser, television, and inertia. The range of the missiles usually varies from 8 to 700 kilometers, with the longest range being 1,200 kilometers. After air-to-surface missiles were fitted onto bombers, it was not necessary for the bombers to fly over the target and drop their bombs, and the missiles enabled them to attack from a position quite far from the target. With this widening of the range of a bomber's attack, its own safety is increased.

(3) The Electronic Equipment With Which Aircraft Are Generally Equipped Strengthens Their Capacity To Break Through the Other Side's Air-Defense Net. After America's B-52 aircraft was equipped with a photoelectric monitoring system, its pilot could clearly observe terrain and manmade surface features over a wide range at night, even on a night when there was only starlight, and, flying at the minimum altitude of 170 meters, break through the other side's air-defense net. To prevent the aircraft from being discovered by radar, it is equipped with many kinds of electronic jamming equipment, which jam the other side's radar. The B-52 is now the bomber in the world with the strongest capability for electronic measures and countermeasures.

After the old-type bombers were fitted with new-type weapons and electronic equipment, there was a very big improvement in their operational capability. As for the new-type bombers, the big improvement has been in their flying performance, for example, in speed, ceiling (the maximum altitude that an

aircraft can reach), and mobility. Take, for example, the Soviet Union's TU-22M Backfire supersonic bomber. Its maximum speed is 2,000 kilometers per hour, its flying altitude reaches 16,000 meters, and its bomb-and missile-carrying capacity is 10 tons, with the use air-to-surface missiles made primary; it possesses the capacity for making a low-altitude breakthrough of the other side's air-defense net and for taking electronic measures and countermeasures.

A long-range bomber's airframe is huge, its equipment is complex, and its cost of manufacture is extremely expensive, estimated at above \$80 million.

#### D. Good Helper for Ground Operations--the Assault Plane

During World War II, when fascist Germany attacked France, it made use of the "Junker 87" dive bomber (also called the "Stuka"); and the Soviet Union made use of an aircraft, the Il-2, to specially deal with ground targets, and it concentrated on attacking tanks, artillery positions, pillboxes, defense works, and groups of infantry in direct support of the army's frontline operations. This kind of aircraft that directly supports the frontline operations of ground units is called by our country an assault plane and by foreign countries an attack plane.

There are supersonic and subsonic aircraft in this category, and their common characteristic is that they possess a fairly strong capability for attacks against the ground, and also that the aircraft has armor to protect the pilot and its important parts like the fuel tank and the engine. Some assault planes have the ability to take off and land vertically, like the previously mentioned "Harrier" of Britain.

The assault plane, bomber, as well as fighter-bomber are all used to attack ground targets, but their missions are not completely identical. The focal point of a bomber's attack is strategic targets or some important big targets in the rear of the battlefront, and the focal point of an assault plane's attack is troop concentration areas, field fortifications, concentrated groups of tanks, and moving columns on the frontline, as well as strong firing points

on the battlefront. As for the fighter-bomber, it is suitable for attacking all targets that lie between these two focal points, like bridges, ports, and field warehouses.

At present various countries are attaching importance to developing assault planes designed specially to attack tanks. The speed of this kind of aircraft is not fast, being 700 to 800 kilometers per hour, but it has a powerful cannon that can pierce a tank's armor and has other weapons for attacks against the ground, has a fairly strong armor protection capability, holds quite a lot of fuel, and is able for a fairly long time (1-1.5 hours) to patrol and search for targets in the war zone. The A-10 plane, with which America has newly equipped its units, is just this kind of aircraft. The A-10 is 16.26 meters long, has a wing span of 17.53 meters, and its maximum speed is 830 kilometers per hour. Under its wing and fuselage are 11 pylons, from which various kinds of weapons can be suspended, including the "smart" bombs, air-to-surface missiles, rocket projectiles, and so forth; the A-10's maximum

bomb- and missile-carrying capacity is 7,260 kilograms. On its nose is a seven-barrel rotating gun, which shoots 4,200 rounds per minute and is specially used against tanks. To prevent it from being shot down by ground fire, many protective techniques have been adopted. For example: the aircraft has 1,170 kilograms of protective armor, among which is a 37-mm thick titanium alloy steel plate all around and at the bottom of its cockpit. It has two engines separately mounted on the two sides of its upper fuselage; even if one of the engines is destroyed the remaining one can still function. Inside the fuel tank is fire-extinguishing foam material to prevent the fuel tank from catching fire after it is hit. There are two each of the aircraft's primary work systems (control, hydraulic pressure, and electric) separately mounted on the two sides of the fuselage to insure that they are not hit and damaged at the same time.

The attacks of assault planes need to be closely coordinated with the actions of units on the ground, and so ground-to-air liaison officers and appropriate means of communication must be provided to the army units. At the same time, the assault plane base should be fairly close to the frontline, so that it coordinates its operations with the army. Because this kind of aircraft has a weak capability for aerial combat, it needs fighter cover when it goes into action.

#### E. Promising Youth--the Armed Helicopter

The armed helicopter is a combat aircraft that has been developed in the recent 10-odd years. During the 1960's, on the Southeast Asia battlefields, America first added machineguns and other weapons to a light helicopter used for transporting troops, thereby turning it into an armed helicopter. Afterward, on this foundation, it narrowed the helicopter's fuselage, enhanced its engine's power, and increased its protective armor and fuel capacity, thereby turning it into a special armed helicopter, the AH-1. On the foundation of the Mi-8 helicopter, the Soviet Union also made an armed helicopter, the Mi-24. After the Soviet Union invaded Afghanistan in 1979, it once used a large number of this kind of helicopter to suppress the Afghan people. Because the armed helicopter does not need a special airfield it can take off and land on a small patch of ground, and because it has fairly strong firepower and is easy to maneuver, it is particularly suited for operations in mountainous regions. It is said that the Soviet Army is now equipped with about 900 Mi-24 armed helicopters. The U.S. Army already has more than 1,850 armed helicopters.

The modern helicopter and the old-type helicopter are completely different. The old-type helicopter was slow and inflexible. The fastest speed of a modern helicopter is 500 kilometers per hour, which is faster than that of an old-type assault plane. The speed of the ordinary armed helicopter is 370 kilometers per hour. Some modern helicopter can perform movements that in the past only fighters could perform, like double somersaults and horizontal rolls. Having this maneuverability, when ground artillery fires at it, the armed helicopter can nimbly dodge, making it hard for the shells to hit it. The combat radius of the armed helicopter is already 300 kilometers, and if it uses a special fuel tank and reduces the number of its weapons, the combat radius is somewhat larger.

The firepower of the weapons with which the armed helicopter is fitted is very strong. On its nose is a flexible machinegun or machine cannon; on the two sides of its fuselage 6 to 8 weapons can be attached, like 4 rocket launchers (with a total of 128 rocket projectiles that are 57 mm in diameter) and 4 antitank missiles. Operated by radio, a missile can hit a tank 3,000 to 4,000 meters away, has an armor-piercing capability sufficient to pierce a 200 to 300mm-thick steel plate, and there is no difficulty in using the missile to strike a blockhouse. Some armed helicopters are fitted with equipment for nighttime observation of targets, like the infrared viewer or the low-light level television. On a very dark night, the pilot can find targets on the ground within three to five kilometers. Some armed helicopters (like the Mi-24) can also carry six to eight armed soldiers, and, during an operation, transport the soldiers to a mountain pass, bridgehead, or other specially designated area, and then give them fire cover from the air. After the fighting the helicopter will once again land and take the soldiers away.

Modern warfare is three-dimensional warfare, and there is no division into front and rear. With the armed helicopter, this characteristic is reflected more distinctly. On the Southeast Asia battlefields, America's armed helicopters flew over the frontline directly into Vietnam's rear, where they seized village cadres, destroyed storehouses and goods, captured prisoners-of-war, and so forth. This shows that the armed helicopter has a very big potential in this respect. Following the constant improvement of the helicopter's performance, the armed helicopter can fly very fast, ordinary radar cannot pick it up, and the possibility of armed helicopters making surprise attacks on strategic points, airfields, television stations, oil depots, granaries, and railroad stations in the enemy's rear has become greater and greater. If a country does not attach importance to air defense, lowers its guard and becomes careless, it will sustain very great losses in wartime.

There now exist some shortcomings in the armed helicopter that are not easy to overcome. For example, when in flight it makes a lot of noise, which can be heard very far away, and thus it is easily discovered and attacked by the other side; and the glass cover on the cabin (called the wind screen and canopy) has a strong light-reflecting capacity and in daytime is also very easily picked up by the other side. In addition, although the armed helicopter has armor protection, the bulletproof capacity of its canopy is still fairly weak and so the canopy is easily hit and smashed. The helicopter's rotary wing and empennage are fairly easy to hit and damage, and if they are damaged the helicopter cannot fly. In brief, its ability to withstand ground fire attacks is not high and its survivability is fairly low.

#### F. Combat Aircraft of the Future

Following the high-speed development of modern science and technology, there will occur many changes in the combat aircraft of the future.

(1) Every Kind of Combat Aircraft Will Be Able To Take on More and More Combat Missions. The distinction between fighters, fighter-bombers, and bombers will be very unclear. For example, the fighter of the future not only will have a strong capability for aerial combat but will also be able to carry 3- to 5-ton

bombs, and its bomb- and missile-carrying capacity will be greater than that of some modern bombers or fighter-bombers; and the assault plane, bomber, and even the armed helicopter of the future will be able to use new-type guided missiles used in aerial combat and will also be able to engage in aerial combat.

(2) Degree of Automation Will Become Greater and Greater. The combat aircraft of the future will be equipped with a lot of electronic equipment, and, in particular, the microcomputer will compute at any time based on the requirements of combat, displaying the results of its computations to the pilot. To complete his missions, a pilot will not need to remember a large amount of data and make complex calculations; only in accordance with the tactical situation at the time and the displayed results of the computer's calculations will he make a judgement, come to a decision, and determine the times to drop bombs or open fire, or to fly to a certain place.

(3) There Will Be Less and Less Dependence on Airfields. A modern fighter can take off and land on a runway 800 meters long. The combat aircraft of the future will be able to take off and land in an even shorter distance, and a straight section several hundred meters long on a national defense highway can be made into a temporary takeoff and landing field for aircraft.

(4) Attacks by Combat Aircraft Will Be More and More Unexpected. The performance of the missiles of the future will be greatly improved and their range will become longer and longer. A combat aircraft will fire its missiles at a fairly long distance to destroy its target, and the unexpectedness of its attack will be increased.

### 3. Special Kinds of Aircraft for Carrying Out Special Missions

#### A. Eyes and Ears of the Armed Forces--the Reconnaissance Plane

Modern reconnaissance aircraft can be divided into two big categories: tactical reconnaissance planes and strategic reconnaissance planes. The strategic reconnaissance plane mainly reconnoiters the major military operations, military projects and installations of the other side, as well as other situations in economic construction and in communications and transportation that possess significance for the overall situation. Usually it makes use of the method of photographing large areas from high altitudes to complete its mission. The tactical reconnaissance plane is mainly used for campaign and battlefield reconnaissance, and it reconnoiters specific developments of the other side's armed forces, like infantry assembly areas, tank assembly areas, artillery positions, and missile positions. Usually it makes use of the method of medium- and low-altitude photography to complete its mission. In addition, there is an electronic reconnaissance plane, which is given a special introduction in Chapter 10.

The great majority of reconnaissance planes are refits of combat aircraft on active duty. Usually, some weapons on a combat aircraft are taken off and special reconnaissance equipment is added, like optical cameras, infrared cameras, electronic signal-receiving equipment, and so forth. The performance of the aircraft and the performance of the original combat aircraft are basically the same, and that of some aircraft is even better (because the weight is lightened). Unless they are specialized personnel, people cannot easily distinguish from an aircraft's appearance whether it is a reconnaissance plane or a fighter plane.

The majority of strategic reconnaissance planes have been specifically developed, like America's U-2 and SR-71.

A characteristic of these aircraft is that they fly high and are able to reach a higher altitude than ordinary fighters, so it is not easy for fighters to shoot them down. America's SR-71 strategic reconnaissance plane not only flies high (about 22,000 to 24,000 meters) but also especially fast, 3,200 to 3,600 kilometers per hour.

After the 1960's, the reconnaissance capability of artificial satellites became greater and greater, and these satellites are already able to complete all the missions undertaken by strategic reconnaissance planes. Circling the earth about every half hour, an artificial satellite can quickly reconnoiter a large area. Also, it is universally accepted internationally that the space above an altitude of 100 kilometers does not fall into the category of territorial airspace, but is under international ownership, so the photographing of another country by a satellite passing over it does not count as a violation of that country's territorial airspace. Therefore, some strategic reconnaissance missions have already been handed over to satellites.

Besides visual reconnaissance, there are three other means of aircraft reconnaissance:

(1) Optical Photography. Every reconnaissance plane often carries five to six cameras, some of them pointed in the direction directly under the plane, and others pointed to the left, right, or front. By passing over the target area one time, this kind of aircraft can take pictures of the entire earth's surface between its left horizon and right horizon. Also, some camera lens "swing" (and some cameras have a prism on the lens that swings), so that, when the plane passes over the target area it only takes one camera to take a picture of the earth's surface from the left to the right horizon. The pictures taken by aircraft reconnaissance depend upon specialized personnel for their interpretation. With the present standard of optical photography, the range within which objects can be distinguished on the earth's surface is approximately equal to 4 to 5 times the flying altitude. For example, when a reconnaissance plane flies at an altitude of 20,000 meters (20 kilometers), physical objects in the pictures it takes can be distinguished within a range of 80 to 100 kilometers from its two sides.

(2) Infrared Photography. Infrared photography is a means of reconnaissance that has been very rapidly developed in the past one or two decades, and it can be used day and night. Modern infrared photography may also be divided

into three kinds: First, there is the photography done by the direct infrared camera. The color photographs taken by this camera are different from natural color photographs. Green plants appear to be red, and tanks painted the same color of green or the green camouflage on artillery positions, because of their weak reflection of infrared rays, appear to be greenish blue or greyish blue. Therefore, in infrared photographs it is very easy to see through the camouflage of weapons on the ground. Another kind of infrared photography is that done by the infrared viewer. With this instrument personnel in the aircraft can directly "see" the thermal images of objects on the entire earth's surface, and can also take photographs of the images and store them. The infrared viewer of the present time can pick up a target one meter in size at a distance of 1,000 meters. If the plane is flown at a low altitude, the viewer can find in an oblique direction a tank 5 to 10 kilometers away and an aircraft more than 30 kilometers away. The third kind of infrared photography is that done by the infrared scanning camera, which has an infrared scanning device and an infrared sensor. The lower the temperature of the infrared sensor the higher is its sensitivity. Because this device only has one sensor, it can be placed inside a particularly small cavity in which the temperature falls below  $-190^{\circ}\text{C}$ , and provided the temperature difference between objects is more than  $0.25^{\circ}\text{C}$  the sensor can "sense" them. Therefore, photographs taken by this method are original. For example, the infrared scanning camera can photograph the "shadow" left behind by an aircraft which flew by a short while ago, and also can photograph oil pipes or water pipes buried 3 to 5 meters under the ground. These are things that ordinary optical photography cannot take pictures of, but they can be discovered by infrared scanning photography.

(3) Radar Photography. The third means of reconnaissance is to use radar on aircraft to observe the earth's surface, look for targets, and then take pictures of them. There are many kinds of radar. The resolving power of the great majority of radar now on board aircraft is not high: of the images of the earth's surface seen on the radar scope, only rivers, sea coasts, islands, large bridges, and airfields can be distinguished; targets that are a little smaller cannot be seen. The radar on aircraft that has the best resolving power is the "synthetic aperture" radar, and the degree of clarity in the images on the earth's surface that it displays is already almost as high as that of optical photography; its reconnaissance range is 100 kilometers from the aircraft's two sides. Radar photography is ordinarily not affected by weather conditions such as clouds, fog, rain, or snow, and the pictures it takes in the day and at night are basically the same, so that in these respects it is superior to both infrared photography and optical photography.

#### B. Sentry in the Sky--the Airborne Radar Warning Aircraft

The use of ground warning radar to keep watch on the sky so as to prevent surprise attacks by enemy aircraft is extremely effective. However, the earth is round and radar's electromagnetic waves are disseminated in straight lines, so no matter how great a power the radar has, provided an aircraft drops to a low altitude, the distance at which the radar can detect it will be shortened. When an aircraft's flying altitude is 100 meters, the radar's detecting distance is only 30 to 40 kilometers. Obviously, it is very hard to prevent a surprise attack by enemy aircraft with such a short detecting distance.



The situation is somewhat better if the warning radar is set on top of a mountain. Therefore, some people proposed that warning radar be installed on aircraft so that it could perform its warning function while airborne, and this idea later became a reality. An aircraft in which warning radar is installed is called an airborne radar warning aircraft. The detecting distance of a radar warning aircraft can be as far as 300 to 400 kilometers, and within this range all aircraft in the air, even those flying close to the ground, and those taxiing on the runways of airfields to take off can be discovered, and also their situation at all times can be reported. For example, in 1981, when the war between Iran and Iraq was intense, America dispatched several aircraft of this kind to Saudi Arabia in order to monitor the situation on the battlefield. As soon as an aircraft of either side was sent on a sortie, America knew about it.

Airborne warning aircraft are usually refitted from large aircraft; the loading capacity of these aircraft is fairly big, and they can be flown for 8 to 9 hours in succession. Some airborne warning aircraft are at the same time airborne command posts that can command aerial combat. The radar of America's E-3A radar warning aircraft can simultaneously track 500 targets in the air, and with the computer's help can, from the ground clutter, ascertain the altitude, speed, and position of 240 targets (this is a fairly advanced feature, as ordinary radar cannot see aircraft flying close to the surface, because the surface reflects radar waves, which are mixed in with the aircraft's returning radar waves, making it very difficult to differentiate between the two kinds of waves). When the aircraft is flying at a high altitude of 9,000 meters, its radar's longest detecting distance is 400 kilometers. The cost of one of these aircraft is \$150 million, making it the most expensive aircraft in the world. At present, the only countries that are able to produce radar warning aircraft are America and the Soviet Union. A radar warning aircraft, which Britain developed by itself, is now being flight-tested.

#### C. Filling Station That Can Fly--the Air Refueling Tanker

When a car is going along on a road and it is discovered to have insufficient gasoline, the driver can find a filling station and get the car refueled.

In order to fly a long distance, an aircraft can also land at the half-way point and get refueled. However, an aircraft carrying bombs is usually not allowed to land unless it has first dropped its bombs. In addition, it is very difficult to find a suitable airfield on the way to land and get refueled. Even if there is a suitable airfield, landing and refueling waste time. Therefore, the technique of refueling in the air has already been widely applied for bombers, and even fighters and helicopters can be refueled in the air.

A large passenger plane or bomber is converted into an air refueling tanker. During refitting, the aircraft's cabin is converted into a fuel tank and filled with fuel. A fuel pipeline is installed in the lower rear part of the fuselage, and there are two kinds of fuel lines, soft and hard. On the fuselage of the aircraft being refueled, there is an air fuel line. On a fighter this fuel line can be retracted, thereby reducing drag. During the

refueling in the air, the tanker maintains a smooth and steady flight at medium altitude and medium speed as it lets out the fuel line. The plane to be refueled follows in its rear and flies close to the air refueling tanker. The fuel line is then securely connected by mechanical means to the plane to be refueled. After the fuel line is securely connected, the plane to be refueled sends a signal to the refueling tanker, which opens a valve to let the fuel flow. The operating techniques of this refueling method are fairly complex, and the pilots must have a fairly high degree of flying skills to refuel in the air.

Some aircraft that are not air refueling tankers can also refuel other planes in the air. The way this is done is to attach two large fuel tanks (in appearance like bombs) under the wing of this kind of aircraft. At the rear of each fuel tank is a soft fuel line that can be rolled up. The fuel line is let out, and fuel from the outboard tank is conveyed to the aircraft being refueled. After the refueling is completed, the fuel line is taken back and rolled up.

At present, the total-fuel carrying capacity of a large air refueling tanker can be as much as 160 tons. Every time a large fighter is refueled it only needs 2 to 3 tons, so one air refueling tanker can refuel more than one fighter at the same time. The capacity of an outboard refueling tank is somewhat smaller, usually only 1.5 to 2 tons of fuel.

When an aircraft is refueling another in the air, the two aircraft must be at the same speed and in a straight line, flying very smoothly and steadily, and must especially avoid colliding with other other. The time taken for air refueling is about 10 to 15 minutes, and in a period of combat this is an extremely dangerous moment as the aircraft are easily attacked by the enemy. Therefore, there must be a high degree of secrecy as to the air refueling area that is selected, and the area must be constantly changed. At the same time a certain number of fighters must be sent to cover the refueling operation.

#### D. Other Special Aircraft

There are many types of special aircraft, each having its own use. For example: aircraft fitted with "magnetic field abnormality detectors" or sonar, which are specially used to discover submarines, are antisubmarine aircraft; and aircraft fitted with various kinds of electronic countermeasures equipment are electronic jamming aircraft or electronic reconnaissance aircraft. There are also the artillery fire-control plane, which coordinates with artillery operations; the pilotless plane, which carries out reconnaissance or other missions; the target plane, which is used for target practice; as well as the transport plane that rescues wounded and sick personnel; and so forth.

With the progress made in modernized automatic control technology, already any aircraft can be transformed into a pilotless plane. After being refitted, the aircraft can automatically take off from an airfield's runway, ascend to a predetermined altitude, and perform certain maneuvers and movements, all without needing the intervention of a pilot or personnel on the ground. Of course, all of the flight movements of this pilotless plane must be well programmed beforehand and the program stored in the plane's computer, which

will then control the plane's flight. Only at the necessary times will ground operators send radio commands to adjust the plane's movements. It is obvious that this kind of special aircraft can complete many kinds of missions. It can complete whatever mission is unsuitable for a human to pilot an aircraft, for example, an aircraft that is acting as a target plane, a sampling plane in an atomic bomb test, and forth.

#### 4. Fast Transport Aircraft

##### A. Fastest Means of Transport

A modern war consumes a large amount of goods and materials, and the timely replenishment of weapons and ammunition has an extremely great bearing on the outcome of a war. For example, at the beginning of the Fourth Middle East War, Israel suffered a big loss and was on the verge of destruction. America then made an emergency airlift of war materiel to Israel. The one-way distance from America's logistic base to the Israeli capital was 11,900 kilometers. Within a little over 20 days' time, America lifted a total of 27,895 tons of weapons and ammunition, aircraft spare parts, and tanks, fully showing that modern airlift capacity had already reached a very high level.

At present, the largest transport plane in the world is America's C-5A, with a length of 75.54 meters, height of 19.86 meters, and load-carrying capacity of 100 tons. At one time it can transport 345 fully armed soldiers or 2 M-60 tanks or many trucks. This aircraft has four jet engines and its speed is 860 kilometers per hour, more than 10 times as fast as a train and more than 20 times as fast as a steamship, making it the fastest means of transport. Fully loaded the aircraft can fly 5,000 kilometers without being refueled in the air; if the load is reduced to 51 tons, it can fly more than 10,000 kilometers.

At present, the Soviet Union's largest military cargo plane is the An-22, and in size it is close to America's C-5A. A railroad passenger car can be put in the cargo bay of its fuselage; and its maximum cargo-carrying capacity is 80 tons. However, the engines used on this aircraft are not of the jet type but of the turboprop type. The aircraft's speed is a little slower than that of America's C-5A, averaging about 600 kilometers per hour.

To make it convenient to land and unload the cargo on the aircraft, there is a large door at the front or lower rear of the fuselage of a military transport plane, from which a ramp can be lowered so that self-propelled artillery pieces, tanks, and motor vehicles can directly enter and leave the plane. On the floor inside the plane there are usually many small rollers, which make it fairly easy to push the cargo forward. Some transport planes also have small winches traveling on gantries, which are used to shorten the loading and unloading time.

Large cargo planes have one common drawback, namely, they impose high demands on airfields. They must take off and land on a thick cement runway that is more than 2,500 meters long (that of a first-class airfield). Therefore, these aircraft are unable to transport military materiel directly to the vicinity of

the frontline, and the materiel must be shipped by other aircraft or means of transport.

In addition to large transport planes, various countries attach a lot of importance to the development of medium transport planes with a transport capacity of about 10 tons. Modern medium transport planes are able to take off and land at short distances and on unpaved, simply built runways, thus making up for the drawbacks of large transport planes.

#### B. Transport Planes That Do Not Need Large Airfields

Helicopters only need a place about 50 x 50 square meters on which to take off and land, and they are extremely convenient for transporting weapons and personnel. The speed of modern helicopters has been raised to over 400 kilometers per hour and their range to between 600 to 800 kilometers. The greatest merit of a helicopter is that it can transport military materiel to a frontline that lacks airfields, or it can secretly transport airborne units to the enemy's rear.

Currently, the maximum weight a helicopter can hoist-transport is 8 to 10 tons. Hoist-transport is a method of transport in which steel cables hanging from the belly of the helicopter are hooked onto an object, after which the helicopter ascends. As the helicopter flies, the object is hoisted in this manner from beginning to end. This method is only used for short-distance transport.

The modern helicopter has a drawback in that its engine power is affected by temperature and air pressure. If the temperature is high and the air pressure low, the air density falls and so does the engine's horsepower. In the south, when the summer temperature is very high, the transport capacity of the helicopter is greatly decreased. On a plateau, the air pressure falls and the helicopter is unable to transport many things. Of course, a helicopter should be able to take off vertically, but in high temperatures or in highland areas, the helicopter, like an ordinary aircraft, must run along a section of ground before it can take off. Therefore, when helicopters are used in highland areas they should take off and land in the morning or evening, when the weather is cool, and a "runway"(about 200 to 220 meters long) should be built for the helicopters.

#### C. Airlanding and Airdropping of Materiel

When a transport plane has airlifted material to its destination, it usually lands and has its cargo unloaded. This is called airlanding, and it is the best way to airlift materiel. However, in time of war, the airfields in the vicinity of the frontline are not necessarily safe, and in some areas there is no airfield upon which aircraft are allowed to land. At this time, aircraft that depend on a runway to take off and land are unable to airland materiel, but they can adopt the method of putting parachutes on the materiel and dropping it from the aircraft, a method called an "airdrop" or "paradrop."

In the past, in order to airdrop materiel the weight of each piece had to be restricted, because the weight that a parachute could bear was limited. Modern

technology has increased this weight of a single piece to several tons. A motor vehicle, a large artillery piece, or a light tank can all be airdropped without being damaged. To airdrop this kind of heavy materiel requires several parachutes, and there are two difficult technical points involved: The first difficult point is how to insure that the several parachutes open simultaneously to take the weight. If one parachute opens before the others, it will take too much weight and collapse from the drag, and when another opens the same thing will happen, this gradual callapsing will lead to the failure of the airdrop. Now, a control mechanicsm causes the parachutes to open simultaneously. The second difficult point is how to insure that when the materiel lands on the ground it will not strike it too hard. the current method of solving this problem is to attach a "probe" that points downward from the lower part of the object and to attach one or several rockets between the parachute and the object. The exhaust nozzles of these small rockets point downward, and they are connected to the probe by electric circuits. When the airdropped object is just about to hit the ground, because the probe strikes the ground first the rockets are immediately ignited and their downward jet produces a reacting force upward. Thus, at the instant the object is about to contact the ground it is "pulled up" by the rockets and its speed in contacting the ground is slowed. In addition, between the airdropped object and its parachutes there is a "self-exploding" device (an explosive bolt), which immediately separates the object from its parachutes when it touches down, thereby preventing the object from being dragged by wind blowing the parachutes and causing unnecessary damage it it.

In the recent 10 or so years, based on operational requirements, there has also been developed an airdrop method in which the aircraft flies very close to the ground. It is a method that lies between an airdrop and an airlanding. After a military cargo plane flies to its destination, it flies very close to the ground (no more than five meters from the ground) at a slow speed. Objects in the aircraft are attached to small parachutes, dragged to the rear of the aircraft and tossed out to the ground. The aircraft then swiftly puts on speed and rises, leaving the dropping ground. The essence of this method is that the aircraft does not stop to land but rather throws the objects to the ground forcefully, so, when the objects are being dropped, the aircraft's altitude and speed must be strictly controlled. By this method objects can be released more quickly, and aircraft turnover is fast. If an aircraft stops to land at an airfield already under the threat of enemy artillery fire, it can be hit at any time, and this method increases the aircraft's safety.

#### D. Airborne Forces, Which Make Full Use of Airlift Capacity

Airborne forces are operational units that, after riding in aircraft to their destination, either jump by parachute or are airlanded. The mobility of airborne forces mainly depends on aircraft. The strength of the weapons and equipment of an airborne force is directly related to the parachutes or to the riding capacity of the aircraft that lands it.

On 9 April 1940, when fascist Germany invaded Denmark and Norway, airborne forces were used for the first time.

In the 1930's and 1940's, the only airborne method was to drop personnel and weapons by parachute. However, this method was too greatly affected by weather

conditions; and the personnel and equipment dropped were very scattered and it was very difficult for them to assemble. Following the development of modern helicopter technology, the methods of parachuting airborne forces and landing them by helicopter were used simultaneously. There are many merits in airlanding by helicopter: the personnel and weapons are easily assembled, and repeated airlandings can be made. Parachute airborne forces can only move by air one time, because ordinary aircraft cannot land and pick up the units they have dropped. If the helicopter is made one of the principal means of transporting airborne forces, the situation becomes completely different. Helicopters are able to land and take off everywhere, and the units can be repeatedly moved in the air. This kind of airborne force will play an even bigger role in the future. At present, the drawback of a helicopter is that its range is not long enough, and therefore units must sometimes be airdropped by ordinary transport planes.

The weapons and equipment used by airborne forces are basically the same as those used by the ground forces. In the past, because of the restrictions on the carrying and airdropping capacity of aircraft, it was very difficult for an airborne force to be fitted with heavy weapons. However, the modern transport plane and helicopter can transport big guns and medium tanks, thereby strengthening the weapons of an airborne force.

## 5. Tight Air-Defense Network

### A. Sentry on Duty Day and Night--Radar

Since ancient times, the majority of wars have begun with a sudden surprise attack. Modern wars also more often than not begin with a surprise attack by an air force and strategic missiles. Aircraft move swiftly, 50 to 60 kilometers per minute at the fastest; the speed of strategic missiles is even faster, some reaching 400 kilometers per minute. To meet the needs of air defense, there must be a set of installations that keep watch on the territorial airspace. "Radar" is the equipment that is specially used for this mission. When radar is operating, it sends out electromagnetic waves, and if there are aircraft or missiles in the sky some of the electromagnetic waves are reflected back and the aircraft or missiles are picked up immediately. The air force of each country has a radar force, which is distributed at all important areas in the country. Every radar station can watch over an area with a radius of about 200 to 300 kilometers. A large radar station can "see" aircraft at high altitudes 400 to 800 kilometers from the station. Super long-range warning radar can pick up strategic missiles at an altitude of 1,300 kilometers more than 5,000 kilometers from the radar. Through close cooperation the various kinds of radar and the various radar stations comprise a tight defense surveillance network.

At present, there are many types of radar used in the air-defense systems of various countries: warning radar (to search for and pick up targets), guiding radar (to guide interceptor attacks to targets), aiming radar, and weather radar (to detect thunder, rain, and clouds). The newest type is the phased array space tracking radar, which can simultaneously perform many tasks, such as warning, guiding, tracking, aiming, and finding heights, and which can

within 30 seconds track 300 targets and calculate the points of impact of more than 200 targets (intercontinental missiles).

Modern radar has become the eyes and ears of an air force. Whether the air force can discover enemy aircraft as soon as possible and timely intercept them, and whether the areas and units concerned can put up an air defense in good time, are questions relating to how well the radar stations do their work. A radar station is usually sited in the vicinity of a country's boundary or on an island, and there are not necessarily a large number of troops surrounding it. The radar station's information is usually transmitted to the command departments by means of radio, telephone, or wired transmission system. When a war breaks out, radar is often the first target of attack. Therefore, it is a joint military-civilian task to guard against raids on radar stations by secret agents or armed helicopters sent by the enemy. In particular, the communication lines of a radar station must be well protected; otherwise, it will be unable to transmit the information on enemy aircraft it has obtained, and so the chance of winning a battle will be bungled and serious losses will be incurred.

#### B. Air-Defense Missiles and Antiaircraft Guns

The air-defense mission that an air force is charged with is, in the main, territorial air defense, and most of the targets it defends are important cities, industrial bases, military bases, as well as all places of important strategic significance. The air-defense missiles and antiaircraft guns used by the air force are basically the same in type, structure, and function as the air-defense missiles and antiaircraft guns used by the army in field air defense. What is different is: in territorial air defense, the scope of defense is broad and the targets to be defended are fixed. Therefore, a large number of medium-sized missiles and antiaircraft guns are put in fixed positions, forming an in-depth defense network. In field air defense, the scope of defense is small and the defense must be mobile. Therefore, small and medium-sized missiles and antiaircraft guns are employed.

The air-defense missile is the main combat strength of an air-defense system. Its types, structure, and function were introduced in detail in Chapter II on ground forces, and will not be discussed further. The several regional wars since the 1960's prove that the air-defense missile has a long range, is highly accurate, and is very powerful, truly an effective weapon for air defense. But it is not as unfailingly accurate and infinitely resourceful as the propaganda of certain countries maintains.

The air-defense missile is a modernized weapon and is fairly complex. If used properly it can play a very big role; if disrupted by the other side it will probably not be able to play this role. The great majority of air-defense missiles are controlled and guided by special radar or radio commands, and each missile system has a series of radar vehicles and command cars. For this reason, neither missile positions nor radar positions are easily camouflaged, and they are easily raided and destroyed by small detachments of aircraft that are neutralizing ground fire.

In making use of air-defense missiles, a problem easily arises, namely, sometimes the enemy and one's own side are not distinguished and one mistakenly attacks one's own aircraft. So when using air-defense missiles, there certainly must be tight organization to prevent the occurrence of mistaken attacks.

After air-defense missiles began to be widely used, there arose the view that there was no longer any scope for the capabilities of antiaircraft guns. The regional wars since the beginning of the 1960's have shown that this view is incorrect. Figures published by America show that in the Southeast Asia War 80.3 percent of the aircraft shot down were shot down by antiaircraft guns and light weapons. Even America's Phantom aircraft and the F-109 supersonic fighter were at times shot down by 12.7mm antiaircraft machineguns.

Thus it can be seen that antiaircraft guns still have a definite role in modern warfare. The reaction time needed for antiaircraft guns to open fire is a little less than that of air-defense missiles, and the antiaircraft guns can play a very big role in shooting down low-altitude aircraft. Air-defense missiles are more effective against medium- and high-altitude aircraft. Therefore, the results of coordinated operations by antiaircraft guns and air-defense missiles are quite good.

There is not much variety in modern antiaircraft guns. If they are differentiated by caliber, the biggest caliber antiaircraft guns have a caliber of only 100 to 130 mm; each shell weighs several tens of kilograms, and only a few shells are fired per minute. This kind of gun is suitable for coping with high-altitude aircraft, particularly heavy bombers. It is usually aimed and fired in coordination with radar. The reaction of a medium-caliber (57 to 35mm) gun is a little faster than that of a big-caliber gun; it fires 15 to 20 rounds per minutes, and is suitable for coping with medium-altitude targets. In recent years, there has been a fairly fast development of small-caliber antiaircraft guns, and their main purpose is to cope with aircraft which have breached the defense line at low altitude.

The price of an antiaircraft gun is lower than that of a surface-to-air missile, it is convenient to use and more suitable for militia to use than a missile. The future of the antiaircraft gun is headed in the direction of becoming more electronic and more automated, having a higher firing rate, and being more powerful. It will not fall into disuse, but will make use of new technology and equipment, so that it will suit the requirements of modern warfare.

#### C. Automated and Semiautomated Air-Defense Systems

Radar, air-defense missiles, and antiaircraft guns cannot in themselves form a complete air-defense system; only with the addition of the fighter air arm and the people's air defense force, in particular a command system and a communication system that will organize all the weapons, equipment, and personnel, will a complete air-defense system be formed.

A people's air-defense force is extremely important to a country with a vast territory. This is because, in order not to be discovered by radar, many



combat aircraft frequently fly at low altitudes; at the same time their speed is not fast and they are not maneuvering but only flying in a straight line at the same altitude. This provides the personnel of the people's air-defense force with an extremely good opportunity to hit the aircraft. When the personnel of the people's air-defense force of the entire country come out to strike at aircraft, the results of the battle are very evident. Facts prove that it is still effective to use light weapons to hit low-altitude, cruising aircraft. In particular, providing the units and people's air-defense personnel with large numbers of shoulder-fired missiles that are used by a single individual (like the ordinary antitank rocket launcher) for specially hitting aircraft that are "passing over" at low altitudes, will greatly improve the power of people's air defense. Without a doubt, this is an extremely important component part of an air-defense system.

Following the development of modern science and technology, the work done by many people in the air-defense system can be replaced by electronic computers, so that the air-defense system becomes automated and semiautomated. What follows is an introduction to an automated and semiautomated air-defense system built by a country in the 1960's to show the general way this kind of system works.

This automated and semiautomated air-defense system was divided into eight defense areas, in each of which was set up a command center and a series of radar stations and air-defense missiles. Each command center was equipped with 2 electronic computers, 1 large-screen controller, and more than 100 display and control consoles. Each command center could be directly linked up with all relevant units. Each department area itself dealt with 300 to 400 individual (or batches of) targets, and simultaneously organized the interception of 100 individual (or batches of) targets. Each defense area was directly led by the central command headquarters. This headquarters had a number of electronic computers and two big screens, and it also had single-person display consoles. The command center of each defense area could automatically collect the information reported by the radar stations, semiautomatically handle and spot targets, semiautomatically select suitable weapons, and automatically provide the calculations to guide them so that the weapons would intercept the target. At the same time, the command center automatically exchanged information with the upper and lower levels and with friendly and nearby command posts, and automatically displayed information and data. In all of this work, only two key links were "semiautomatic," namely, the handling and spotting of targets and the selection of weapons, in which the commander and staff personnel had to take part. That is to say, there was still a role for man to play--judging the hour and sizing up the situation, weighing the advantages and disadvantages--and the work could not be completely automated.

The principal merit of an automated air-defense system is that its reaction is fast. For example, on a large screen in the North American Air Defense Command is displayed the constantly changing enemy air situation, and only 11 seconds later than the true situation. On another large screen is displayed its own side's situation with respect to air-defense weapons; every 5 minutes the situation on this screen is changed. If there were dependence on an ordinary communication net, the command's grasp of these situations would be delayed by 5 to 10 minutes.

The biggest problem existing in this air-defense system was how to prevent breakdowns. This system included tens of thousands of pieces of equipment and a very complex communication network, and if only one link in them broke down the work of the entire system would be adversely affected. For this reason, it was required that for every part and every line there would be two parts (lines) and even three parts (lines), and wherever a breakdown occurred, a spare part (line) would immediately and automatically be put there to keep the system working regularly. Since then, the price of establishing an entire air-defense system has become several times up to several hundreds of times as expensive as a system with a low degree of automation.

## 6. Service Support for Operations by Modern Air Forces

Although a modern aircraft has a very strong operational capability, it cannot do without an airfield and various kinds of service support. In wartime, once an airfield is destroyed, the service support is broken off and the aircraft completely loses its operational capability. Therefore, to defend airfields well, and in particular to provide well the various kinds of support services, are an important job in an air force.

### A. Communications Support

The strongest characteristic of an air force operation is "rapidity." One important requirement runs through the operation--from a radar station discovering a target and reporting to the command post, the commander ordering aircraft to take off and intercept the target, the aircraft ascending into the sky and being guided by units on the ground to the target, and the aircraft shooting down enemy aircraft--unblocked communication and liaison. An air force's opportunity for combat frequently vanishes in a flash. If a communications breakdown occurs in one link in the series of actions in the operation, the operation will probably fail. Therefore, the efficacy of an air force's communications directly reflects the level of its operations.

Air force communications can be divided into two big categories. One category is the communication and liaison on the ground, for example, from the radar station to the command post, and from the command post to the combat unit at the airfield. To this end, there is set up a nationwide (for some countries a worldwide) perfected communication network between air force units. The headquarters should be able to communicate directly by phone with its airfields, bases, and units. This communication system includes wired communication, satellite communication, and longwave global communication; sometimes the system is supplemented by radio communication media such as scatter communication from meteor trails in space and shortwave single-sideband communication. It is said that America's communication system is able to insure that within several minutes the U.S. Air Force Staff Department is linked up with any U.S. Air Force base on the globe. The other category of air force communications is the liaison between units on the ground and aircraft in the air. The main medium for this now is the ultra-shortwave radiophone. Liaison between aircraft is also effected by means of the ultra-shortwave radiophone. The biggest drawback to ultra-shortwave communication is that it is greatly affected by the earth's curvature, so that an aircraft cruising at low altitude 30 to 40 kilometers away from a radio station cannot

be contacted. For this reason, some aircraft are equipped with a shortwave radio to increase their communication range. Generally speaking, the latest technology in any aspect of communications is very quickly applied in an air force.

The radio communication stations used by the air forces of all countries are in the amplitude modulation system, while the radio communication stations of their armies are in the frequency modulation system. The two types of radio stations cannot contact each other. This is an "inconvenience" that was created during the history of the development of radio communications. To effect liaison between an army and an air force, one side or both sides must take measures: for example, installing on aircraft frequency modulation radios specially for liaison with ground units, or providing relevant army units with the amplitude modulation radios used on aircraft.

## B. Navigation Support

Frequently aircraft must fly long distances above the clouds, or operate under complex weather conditions or at night. At these times the pilot cannot see the ground at all, so how can it be insured that the aircraft will not drift off course? This is the mission of navigation support. To this end, there must be set up a nationwide, even worldwide, navigation system, which, with navigation equipment specially designed to help an aircraft orient itself, guides the aircraft on its flight so that it doesn't drift off course.

There are two types of modern navigation equipment. One type needs to be coordinated with ground navigation stations (centers) before it can work, and an example of this type is a radio navigation system. When this system is working, the ground navigation station transmits a certain pattern of radio signals. After the receiver on the aircraft gets these signals, they are immediately calculated and the aircraft immediately knows its position. The other type is "self-sufficient" equipment, which is installed on the aircraft and does not depend on ground "help" to make it work. For example, the magnetic compass indicates the aircraft's position at any given time. A modern aircraft has both types of equipment, which supplement and correct each other.

In an air force, operational navigation and navigation per se are two different concepts, and also two different kinds of service support. The mission of operational navigation is to find out the enemy's situation; provide the most effective plan for using the force of the air arm (including bombing, airdropping, and airborne landing); guide aircraft to their destinations; coordinate with the army and navy in completing various kinds of combat missions by unifying their actions at stipulated times, places, and targets; and insure flight safety.

Operational navigators are divided into two main types. One type works in the aircraft, is called the aerial navigator, and is part of the aircrew. His job is to guide the aircraft on the stipulated flight course, and to complete the operational missions of bombing and launching missiles in attacks directed at the ground, as well as the operational missions of making airdrops and airborne landings. The other type is the ground operational navigator. At a

command post he helps the commander in guiding aircraft to set out on a course, return to base, and conduct operations, insuring that when the aircraft approach the enemy they are in the most advantageous position. The aerial navigator may be a person specially assigned to this job (in a large aircraft) or the pilot who does this job concurrently (in a single-seater aircraft or in a two-seater aircraft in which besides the pilot there is only an electronics officer).

Following the development of automation technology, the methods of modernized operational navigation are already extremely simple and convenient. Before taking off the pilot puts his position setting (indicated by coordinates) in the navigation computometer, after which he sets one by one the positions (a total of 20 or even more) of the target he wants to reach and the checkpoints he wants to pass over on the way. When in flight the pilot, by means of the navigation instruments, can know at any time the aircraft's position (coordinates) and its distance from any checkpoint or the target (displayed in numerals on a special instrument). Thus, the pilot need not worry about drifting off course.

So that the pilot will more intuitively understand his own position, there is now a piece of equipment called a "map displayer," which displays a map on which there is a small aircraft (representing the aircraft that is equipped with this piece of equipment). During the course of the aircraft's flight, the small aircraft on the "map displayer" moves in a corresponding fashion on the map. If it reaches the edge of the map, the displayer automatically extends the scope of the map. The aircraft's geographical position, direction, and flying speed are accurately, distinctly, and visually displayed. The high degree of development in modern navigation technology has caused a relative reduction in the role of navigators deployed on aircraft, and in a modernized large airliner there are two pilots but no navigator. But there has been a relative increase in the number of navigation stations set up and the number of personnel who safeguard and control them.

### C. Weather Support

Although modern navigation technology is highly developed, aircraft are still unable to break free completely from the effects of weather conditions.

The principal weather condition that adversely affects the normal takeoff and landing of aircraft is the visibility at the airfield. Visibility means the longest distance from the airfield at which fairly large objects can be seen with the naked eye, and the unit of measurement for this is the kilometer or the meter. In a heavy fog in which "you can't see your hand in front of you," the visibility is zero. For modern combat aircraft to take off and land safely, the usual requirement is that the visibility at the airfield be several hundreds of meters. However, in this there is a very large relationship to how good the radio equipment at the airport is in guiding aircraft to take off and land. At present, the most advanced equipment (including the corresponding equipment on the aircraft) can insure that when visibility is zero the aircraft is guided to a safe landing.

The lowest height of the cloud layer over an airfield (commonly called the cloud ceiling) also has a very big effect on the landing of aircraft. The great majority of the radio equipment that guide aircraft in landing can only do so at a certain altitude. After the aircraft is lower than this altitude, the pilot must make a visual landing. If the cloud layer is too low, lower than the altitude permitted by the equipment, the pilot will be unable to see the airfield and its runway, and it will be dangerous for him to land the aircraft. Currently, the highest quality equipment can insure that aircraft land safely when the cloud ceiling is zero, but the equipment of the great majority of airfields requires that the cloud ceiling be no lower than 150 meters.

Strong winds also affect aircraft takeoffs and landings. Modern combat aircraft cannot take off and land when there is too strong a direct cross wind. The limit of this wind speed is related to the type of aircraft, and also to the pilot's skill and the condition of the runway at the time. At present, the maximum force of the direct cross wind in which aircraft can safely take off and land is 15 meters per second. The effect of other meteorological conditions on aircraft takeoffs and landings is fairly small. The effect of ordinary rain and snow is not large, but after a snowfall, the runway will be very slippery, which will affect the distance required for a takeoff and landing, and thus there must be a good calculation as to whether the length of the runway is sufficient.

The principal meteorological conditions that affect an aircraft's flight and combat are: wind, temperature, thunder, rain, height of the cloud layer in the target area, visibility, and so forth. Wind affects an aircraft's combat radius. In windy weather, an aircraft's combat radius is, in all cases, smaller than if there were no wind. The higher the wind speed or the lower the aircraft's flying speed, the more marked is this effect. Temperature, particularly temperature at the airfield, also has a very big effect on an aircraft's operational performance. The higher the temperature the lower the engine thrust, and the aircraft's bomb- and missile-carrying capacity and its range and ceiling will drop. When an aircraft in flight encounters a thundercloud, it must either go around the cloud or climb over its top, and this adversely affects its range. In the target area, the thickness of the cloud layer and the visibility has a great bearing on whether the aircraft will be able to complete its combat mission. If the weather is too bad, the aircraft will even probably not find its target.

The mission of meteorological support in an air force is timely, accurately, comprehensively, and continuously to get and provide information on the weather situation in the enemy's area and one's own area, so as to support the units in completing their combat missions.

#### D. Aviation Engineering and Maintenance Support

The aircraft, weapons, and equipment used by a modern air force are extremely complex, and people must perform regular maintenance to insure their normal use. At present, every aircraft on average requires two to three persons to maintain it. If there is to be repair work, even more engineering and maintenance personnel are required for one aircraft. Therefore, an air force

which has 1,000 aircraft must always have as many as 10,000 engineering and maintenance personnel.

The maintenance of aircraft and of aviation weapons and equipment is often divided into several levels. On the safeguard inspection level, at the airfield's take-off line, there is mainly an inspection before and after the flight to see whether there are any "bugs" in the aircraft, and this level is responsible in wartime for the loading of bombs and shells, for refueling, and so forth. If a "bug" is discovered in an aircraft, it should be immediately fixed; if it cannot be fixed, the aircraft or its weapons and equipment should be immediately sent to the airfield's repair shop or to a small repair plant. If the airfield's repair shop or the small repair plant still cannot fix the "bug," then the aircraft or its weapons and equipment are sent to a medium-sized or large repair plant. This level-by-level maintenance system is not completely the same in all countries, but it is all for one purpose, namely, to insure that there is a fairly high rate of aircraft fit for duty. During the Third Middle East War, an Israeli combat aircraft on average made 4 to 5 sorties a day, the highest number being 8 to 10 sorties. The Egyptian president at the time, Nasir, said: "Without the slightest exaggeration it can be said that the strength of the enemy's air force is three times that of its establishment." Later it was proved through investigation that this was because the maintenance equipment of the Israeli Air Force was advanced and the efficiency of its maintenance was high, thereby insuring an extremely high rate of aircraft fit for duty, and not because the U.S. Air Force took a direct part in the war. It is thus obvious that in wartime the support work of aviation engineering and maintenance plays an extremely important role in insuring victory in aerial combat.

## Chapter VII: STRATEGIC NUCLEAR FORCES

The nuclear weapon is an enormously powerful new-type weapon that appeared in the last stage of World War II. Since it possesses a strategic strike capability and occupies a special place in modern military equipment it has received the universal attention of all countries in the world.

On 6 August 1945, Japan's air-defense radar picked up three American aircraft flying near Hiroshima. The air-defense department thought they were reconnaissance aircraft and did not warn the city's inhabitants, but one of the planes dropped a bomb, and Hiroshima City, which was inhabited by 240,000 people, became a ruin amid big fires and strong winds. More than 70,000 people were killed and 70,000 to 80,000 wounded. Afterward, it was learned that an American aircraft had dropped an atomic bomb.

On 9 August of the same year, an American aircraft dropped another atomic bomb, this time on Nagasaki City, Japan, causing serious destruction to this city with a population of 200,000 and killing more than 30,000 people and wounding about 60,000.

When World War II was about to end, the dropping of these two bombs, which caused enormous destruction to city buildings and heavy loss of life, made an extremely deep impression on the common people, and the term "atomic bomb" immediately spread all over the globe.

In the 1950's, the Soviet Union and America in succession successfully developed the hydrogen bomb, which has even greater destructive force, and soon afterward successfully developed carrier rockets with large thrust that could fly several thousands, and even more than 10,000 kilometers. The combination of the atomic bomb and the hydrogen bomb with the large carrier rocket formed the strategic missile nuclear weapon that people now know so well. In the world at present, only five countries truly possess a nuclear strike force, namely, America, the Soviet Union, Britain, France, and China.

### 1. Enormously Powerful Nuclear Weapons

Nuclear weapons are also called atomic weapons, and they include atomic bombs and hydrogen bombs. The neutron bomb is a kind of small hydrogen bomb.

## A. Atomic Bomb, Hydrogen Bomb, Neutron Bomb

(1) Atomic Bomb. The explosion of an ordinary bomb is a violent chemical reaction, during which a large amount of chemical energy is released and a new substance produced, but there is no change in the nuclei of the substance taking part in the reaction. The explosion of an atomic bomb is different. It is a nuclear reaction, and the atomic nuclei of the substance taking part in the reaction change, releasing nuclear energy, commonly called atomic energy. The energy released by the total fission of 1 kilogram of Uranium 235 is about equal to the energy released by 20,000 tons of TNT explosive. This is the reason that the power of a nuclear weapon is greater than that of a conventional weapon.

The power of a nuclear weapon is usually indicated by its TNT equivalent (called the "equivalence" for short). To say that the equivalence of a certain nuclear weapon is 20,000 tons is to say that the energy released when it is exploded is equal to the energy of 20,000 tons of TNT when exploded.

Nuclear energy is the energy released by fission or fusion of atomic nuclei. In the late 1930's, scientists discovered that when a neutron (neutrons are uncharged neutral particles that make up the atomic nucleus) bombarded a uranium atomic nucleus the latter was split into fragments, and at the same time energy and two to three new neutrons were released. This phenomenon is called fission.

The neutrons released by fission could also hit other uranium atomic nuclei, setting off new fissions, thus releasing more energy and more neutrons. By continuing this process, a chain of nuclear fission reactions is formed, called a chain reaction.

The production of a chain reaction is conditional and not as simple as stated above. By striking the uranium atomic nucleus a neutron causes fission, but not every neutron will necessarily cause fission. This is because in a piece of uranium there are foreign substances to varying degrees, and they absorb some of the neutrons; also, because there is a large gap between one atomic nucleus and another, there is the possibility that the neutron will pass between them, not hitting either one and therefore not causing fission. Under these circumstances, the neutron is lost. So, on the one hand, because fission neutrons are constantly produced and, on the other hand, because of the aforementioned reasons they are constantly lost. If in the fissile material system the gain and loss of its neutrons precisely offset each other, the chain reaction will be maintained and it is called a critical system. At this time, the mass of the fissile material is called its critical mass. If in a system more neutrons are lost than are produced, the chain reaction will not be maintained and it is called a subcritical system. Conversely, if more neutrons are produced than are lost, it is called a supercritical system. In a supercritical system, more and more neutrons are produced, the scale of the chain reaction becomes bigger and bigger, more and more energy is accumulated, and finally a violent explosion is bound to occur. A nuclear bomb made by this principle of fission is called a fission or atomic bomb.



Obviously, to explode an atomic bomb the supercritical condition, in which more neutrons are produced than are lost, must be created.

To produce more neutrons, there must be created more opportunities for them to collide with the atomic nuclei of the fissile material. The methods of selecting materials with good fissile properties, increasing the volume of the fissile material, and increasing the density of the fissile material may be used to increase the opportunities for neutrons and atomic nuclei to collide with each other and thus increase the rate that neutrons are produced.

The loss of neutrons can be reduced by the methods of improving the purity of the fissile material by reducing the foreign substances in it, selecting a system with a rational external form so as to reduce the opportunities for neutrons to fly out of it, or adding a reflecting layer outside the system to intercept and return neutrons that escape it.

Although in the periodic table of elements, there are many elements that are heavier than metal and whose atomic nuclei when bombarded by neutrons cause fission, the only two materials usually used for making atomic bombs are uranium and plutonium.

Such being the case, what method is used to create the supercritical condition that will cause an atomic bomb to explode? The following two methods can be used to achieve this. The first method is rapidly to piece together several nuclear charges that are of less than critical mass, so that the volume of the material is increased and it reaches a supercritical state. The second method is to attain the supercritical state by increasing the density of the nuclear charge. The atomic bomb for which the first method is adopted is called a "gun-type" atomic bomb, and the atomic bomb for which the second method is adopted is called an "implosion-type" atomic bomb.

Figure 7-3 [Figures not reproduced] is a schematic diagram of the structure of a "gun-type" atomic bomb. The nuclear charge is in two parts, one ball-shaped and the other cylinder-shaped, and the mass of each one is less than critical. After the primer is ignited and the conventional charge explodes, the cylinder-shaped nuclear charge is pushed into the hole of the ball-shaped nuclear charge, so that the two charges form a whole and reach a supercritical mass. At this time a large number of neutrons are released from their source, so that there is a fast chain reaction that causes a nuclear explosion. The atomic bomb that America dropped on Hiroshima was a "gun-type" one. It was 3 meters long, had a diameter of 0.6 meter, weighed 4.5 tons, and had an explosive power equivalent to nearly 20,000 tons of TNT.

The structure of the "implosion-type" atomic bomb is shown in Figure 7-4. Between the small particles making up the nuclear charge there are many small gaps; by means of the squeezing pressure produced by the conventional charge the density of the nuclear charge is increased, and it reaches a supercritical state and explodes. This atomic bomb is an "implosion-type" one. It is 3.3 meters long, has a diameter of 1.5 meters, weighs 5 tons, uses a Plutonium 239 charge, and has an equivalence of 20,000 tons.

(2) Hydrogen Bomb. The hydrogen bomb is a kind of atomic bomb made on the principle that when the atomic nuclei of the lighter elements (listed at the head of the table of periodic elements) are polymerized they become fairly heavy atomic nuclei and release an enormous amount of energy. The power of a hydrogen explosion is much greater than that of an atomic bomb; calculations show that when one kilogram of fusion material reacts, the energy released is equal to 3 to 4 times the energy released when one kilogram of fissile material reacts. The reaction caused by combining atomic nuclei is called a fusion reaction. The materials suitable for a fusion reaction are deuterium (also called heavy hydrogen), tritium (also called superheavy hydrogen), and lithium. Because deuterium and lithium are isotopes of hydrogen, the nuclear bombs made with these materials are called hydrogen bombs.

Under ordinary conditions fusion will not occur in the atomic nuclei of the lighter elements. Because atomic nuclei carry positive electricity, there is a large repulsive force between them. How can this repulsive force be overcome? It is overcome by heating them, not by several hundreds or several thousands of degrees, but by several tens of millions of degrees and even more than a hundred million degrees. In today's world, what can produce this high a temperature? Only when an atomic bomb is exploded is such a temperature produced. Therefore, there is no shirking the fact that the atomic bomb must act as the "igniter" of the hydrogen bomb. In fact, at present all hydrogen bombs are ignited by atomic bombs. The structure of a hydrogen bomb is shown in Figure 7-5.

Because a fusion nuclear reaction must be achieved in a state of high temperature, people call it a thermonuclear reaction. From this the hydrogen bomb gets its name of thermonuclear weapon.

In comparison with the atomic bomb, the hydrogen bomb has one striking characteristic, namely, it does not have the problem of critical mass, and so the equivalence of the hydrogen bomb can be very large. Hydrogen bombs have already been built that have an equivalence of several hundreds of thousands of tons, several millions of tons, and also several tens of millions of tons. In principle, even more powerful hydrogen bombs can be made, but if the power is too great the bomb will not be used well. In the past 20 years, people have mainly concentrated on two aspects in improving nuclear bombs: One aspect is to devise a way to improve the quality of the product by striving to make the bombs lighter in weight but highly powerful, namely, the miniaturization of nuclear weapons. Formerly, a nuclear bomb with the equivalence of 20,000 tons weighed 5,000 kilograms, but today a nuclear bomb with the same equivalence weighs only 110 kilograms, and is much more convenient to carry and drop. The second aspect is to strengthen certain factors that cause casualties and destruction, or to weaken certain of these factors, in order to suit different operational requirements.

(3) Neutron Bomb. As early as the late 1950's, America began secret research on the neutron bomb, and successfully developed it around 1977, but former President Carter decided temporarily to not put it into production. In 1981 President Reagan decided to produce the neutron bomb, and this bomb drew the close attention of all countries in the world.

In essence, the neutron bomb is a small hydrogen bomb that is specially enhanced for nuclear radiation effect at an early stage, and so it is called an enhanced "radiation bomb."

Compared with an ordinary hydrogen bomb, the neutron bomb has a prominent characteristic: when exploded its resultant shock wave, ray radiation, and radioactivity are much smaller, and only the number and energy of the neutrons produced are greater. These neutrons can penetrate bunkers, brick walls, and tank armor, inflicting casualties on the personnel in or behind them, and not cause any damage to buildings, weapons, and equipment. For example, the early-stage nuclear radiation of a neutron bomb with an equivalence of 1,000 tons is at least equal to the early-stage radiation of a atomic bomb with an equivalence of 10,000 tons. If exploded 900 meters high in the air, it will cause the tank crews within a radius of 300 meters on the ground to lose their operational capability within 5 minutes, and within several days they will die. But the radius of direct destruction caused by its shock wave is only 120 meters and so a great number of the tanks will survive.

Another characteristic of the neutron bomb is that its equivalence is small and so it is convenient to use. The equivalence of a neutron bomb is usually only several thousands of tons, and the degree of contamination by radiation that it causes is less than that of an atomic bomb or a hydrogen bomb. In a very short time after it explodes, units can enter the explosion area and conduct operations. This is of important military significance and makes it a comparatively ideal nuclear weapon.

#### B. Casualty and Destruction Factors of Nuclear Weapons

There is a great difference between the casualty and destruction factors of nuclear weapons and those of ordinary bombs. An ordinary bomb mainly causes casualties and destruction by its strong shock wave and flying bomb fragments.

When a nuclear weapon explodes, in addition to a shock wave, there are ray radiation, early-stage nuclear radiation, radioactive contamination, and electromagnetic pulses. Of these factors, only the radioactive contamination takes effect a little later, and the remaining factors begin to take effect once there is a nuclear explosion.

Its shock wave is the nuclear weapons's main factor in causing casualties and destruction. When there is a nuclear explosion, enormous energy is released in the twinkling of an eye, causing the temperature at the burst point to suddenly rise millions upon millions of degrees and the pressure to sharply rise several billions and even several tens of billions of atmospheres. The product of the explosion, which is at this temperature and high pressure, swiftly and violently expands, strongly compresses the surrounding air, and forms a high-speed, high-pressure blast that swiftly spreads in all directions--this is the shock wave. The diffusion of this explosive blast, which is faster than the speed of sound, collapses buildings and kills or wounds people and animals wherever it goes. However, as the distance it is diffused over increases its destructive effect becomes smaller and smaller.

Ray radiation is the strong rays and heat emitted when there is an explosion. It is also a main factor of the nuclear weapon in causing casualties and destruction. The greater the equivalence of the nuclear weapon the longer the time that it emits rays and the stronger the rays. When a nuclear bomb of 20,000-ton equivalence explodes, the sustained time it emits rays is about 2.4 seconds; and for a nuclear bomb of 6 million-ton equivalence this time is about 26 seconds. When a nuclear bomb is exploded in the air on a clear day, the range of the casualties and destruction caused by its ray radiation is the greatest. It can set afire or melt equipment and buildings, burn or blind people.

Early-stage radiation (or penetrating radiation) also appears within about a dozen seconds after a nuclear explosion, and it is composed of some rays emitted from the fireball and smoke cloud that the naked eye cannot see. Among them are neutrons and C rays (also called gamma rays) that have a very strong penetrating capacity. When they penetrate the human body they damage its cells and cause radiation sickness, which at least causes the person affected to lose his fighting capacity and at most kills him.

Radioactive contamination is a casualty-producing factor that appears fairly late but whose effect lasts for a fairly long time. Within the natural world some elements constantly and automatically release rays from their atomic nuclei, and this property of theirs is called radioactivity. Elements that possess this property are called radioactive elements. Uranium, plutonium, and tritium, which are used to make nuclear bombs, are all radioactive elements. In addition, after many substances are struck by neutrons, they also become radioactive. When there is a nuclear explosion, nuclear materials for which it is too late for a reaction to occur and radioactive substances produced by the reaction become attached to the dust and slowly sink down in it. After several minutes have passed, they begin to create radioactive contamination in the ground near the explosion area. If these rays enter a human body, they will, like early-stage nuclear radiation, cause radiation sickness. What is different is that the time that radioactive contamination causes its effects is fairly long, and the area of serious contamination will continue to exist for several weeks and even several months.

An electromagnetic pulse is an electromagnetic effect produced by a nuclear explosion's instantaneous early-stage nuclear radiation and this radiation's effect on the atmosphere. It is like an electromagnetic wave emitted by an extremely powerful bolt of lightning. However, the energy of the electromagnetic pulse produced by a nuclear explosion is often a great number of times stronger than the energy of lightning radiation. Although it is not dangerous to people, it causes serious jamming and damage to electronic equipment working within an area of several hundreds and even several thousands of kilometers.

The distribution of energy released when an ordinary atomic bomb is exploded in the air is roughly shown in Figure 7-6.

The size of the effect of the various casualty and destructive factors is directly related to the size of the nuclear weapon's equivalence, the form of explosion (underground explosion, surface explosion, air explosion, high

altitude explosion, or underwater explosion), the distance from the center of the explosion, as well as whether protective measures are taken. The table below shows the radii at which nuclear weapons of several different equivalencies when exploded in the air will cause casualties (meaning immediate loss of fighting effectiveness or death) to personnel exposed on open terrain by shock wave, ray radiation, and penetrating radiation.

In fact, these casualty factors have a simultaneous effect on the human body, so personnel suffer casualties of a comprehensive nature.

### C. Kinds of Nuclear Weapons and Ways They Are Used

The total number of nuclear bombs in the world at present exceeds 50,000. The estimates of their total equivalence by the countries is not the same, some countries saying it is 11 to 20 billion tons and other countries saying it reaches 23 billion tons. Based on their different targets of attack, nuclear weapons may be divided into two kinds--strategic and tactical.

The equivalences of strategic nuclear weapons are usually quite large. They are used to attack strategic targets such as the enemy's political and economic centers, communication hubs, national defense industrial installations, navy and air force bases, guided missile bases, and command centers, so as to paralyze his command, cause him to lose his capability for strategic counterattack and his war potential, and put him in a position in which he is unable to sustain the war.

The equivalences of tactical nuclear weapons are usually quite small. They are used to strike at important targets on the battlefield, like frontline command posts, troop assembly areas, groups of tanks, and important lines of communication; and they directly support the campaign and tactical actions of the units.

Based on the different requirements of the service arms, various types of nuclear weapons are made: nuclear land mines, nuclear artillery shells, nuclear air missiles, nuclear depth charges, nuclear sea mines, nuclear torpedoes, and nuclear guided missiles.

Obviously, no matter what type of nuclear weapon it is, an appropriate way of using it is required, namely, the means of delivering it. There are many means of delivery, from which a selection can be made based on different requirements.

Because guided missiles are fast, are highly accurate in hitting their targets, are not easily damaged, and are of many types, they can be widely used to attack various kinds of targets.

### 2. Important Deterrent Force--the Strategic Guided Missile

During World War II, Nazi Germany built two sensational new-type weapons--the V-1 and V-2 guided missiles. In September 1944, the German military began attacking London with V-2 missiles, and by March 1945 had launched 10,800 of them at the city. Even though only half of the missiles hit their targets,

they caused destruction and casualties in the British capital, which had a fifth (9 million) of the entire country's population, because the means of war at that time were unable to cope with them.

After the war, various industrially developed countries, first of all the Soviet Union and America, began, on the basis of the V-1 and V-2, large-scale work to develop guided missiles. The missile developed on the basis of the V-2 missile and propelled by a rocket engine is similar in appearance to an artillery shell, and its flight trajectory is also similar to that of an artillery shell. This missile is called a ballistic-type guided missile. The missile developed on the basis of the V-1 missile and propelled by a jet engine is similar in appearance and mode of flight to an aircraft, and is called a cruise-type missile. Ballistic-type missiles and cruise-type missiles are always used to attack the other side's strategic targets, and they are called strategic missiles.

Strategic missiles are missiles that play an important part in a war's overall situation. Units will also begin to be equipped with strategic cruise missiles.

#### A. Strategic Ballistic Missile

(1) Characteristics. The characteristics of a strategic ballistic missile are long range, fast speed, great power, and high accuracy. Its range is several thousand kilometers up to more than 10,000 kilometers. Therefore, the forces of a country that possesses this weapon need not cross the seas to mount a strategic attack on an enemy country that is within "ten thousand li," but can do so with this weapon. Its average speed is 300 to 400 kilometers per second, and the speed of its warhead when descending is often as high as a dozen and even 20 times the speed of sound. If the enemy country does not have the latest technological equipment, it will simply discover the missile too late. Its warhead equivalence is several hundreds of thousands to several millions of tons, and even more than ten million tons. It is usually accurate to about 500 meters, the highest accuracy being about 200 meters. This kind of power and accuracy is sufficient to destroy any structure on the ground, and even makes it very difficult for strong underground fortifications to withstand the missile's blow. Moreover, there are very many strategic missiles in the world, the total number being more than 4,000, and there are about 17,000 warheads with a total equivalence of more than 10 billion tons. Therefore, this missile has become the most important weapon that is the focus of world attention, and has become the main strength of the strategic nuclear forces of America and the Soviet Union.

(2) Composition. A strategic ballistic missile is composed of three main parts --rocket engine, guidance system, and warhead--and the structure of the missile's body is a connected whole formed of these three parts.

The role of the rocket engine is to provide the missile with flying power. It works on the principle of the reaction force produced by the high-speed jetting out of gas. The rocket engine obtains the oxygen it needs to burn its fuel from the oxidant carried on the missile itself, and thus can operate outside the atmosphere. The general designation for the fuel and the oxidant

is the propellant, which is divided into solid and liquid. On this basis, rocket engines are divided into two kinds--solid propellant and liquid propellant--and missiles are correspondingly called solid-propellant missiles and liquid-propellant missiles.

The liquid-propellant missile has a special tank to store the propellant, which passes through a tube into the engine's combustion chamber and after being burned produces thrust. In the solid-propellant missile, the propellant is directly cast in the engine's combustion chamber, and therefore the solid-propellant missile is comparatively simple and reliable and is safe to operate. The liquid propellant of the present time can be stored in the missile for as long period of time, and the solid-propellant missile likewise maintains a launch state for a long period of time.

To make it fly fast and strike far, the strategic ballistic missile usually has a two-stage or three-stage structure (Fig. 7-7). After the lower-stage is jettisoned the upper-stage rocket engine is ignited, so that the missile continues to accelerate its forward movement.

The missile does not have a pilot, the task of piloting the missile in its flight being done by a set of instruments called the guidance system. Guidance here means control and guidance. The guidance system is composed of a measuring unit, computer, and actuating mechanism, which respectively play the role of the pilot's eyes and ears, cerebrum, and hands and feet.

The targets to be attacked by a strategic ballistic missile are selected on the basis of the overall intent of the operation. After the missile is launched on its flight trajectory, the guidance system controls all its actions in flight, such as shutting off and separating its first-stage engine and igniting the second-stage engine, so that the missile flies on the predetermined trajectory. When the missile reaches the position and speed needed to hit the target, the guidance system issues commands that shut off the last-stage engine and separate the warhead from the missile's body. The warhead then, like an artillery shell leaving a gun bore, flies toward the target. From launch to hitting a target 10,000 kilometers away, an intercontinental missile only takes a little over 30 minutes.

At present some missiles are only equipped with one fairly large nuclear warhead. But to break through the other side's defenses and improve a missile's attack capability, many missiles are equipped with several or several dozen small warheads (usually called projectile heads), which have an equivalence of several tens of thousands of tons to several hundreds of thousands of tons. These missiles are called multiple-warhead missiles. There are three types of multiple warheads--cluster, independently targeted, and mobile--the latter just now being developed.

The projectile heads of the cluster-type multiple warhead follow roughly the same trajectory, but scattered at a certain distance, as they fly toward the targets; the cluster-type multiple warhead is suited for attacks on large cities. The projectile heads of the independently targeted-type multiple warhead can separately attack several targets up to 100 kilometers distant from each other. This not only makes the other side's defense more difficult,

but also causes the attack to obtain better results. The projectile heads of the mobile-type multiple warhead are able to maneuver during the last several dozen kilometers of their flight, making them more efficacious in breaching defenses and attacking targets.

(3) Classification. Currently the following two methods of classification are generally used:

One method, based on the difference in launch point and position of the target, divides strategic ballistic missiles into two types.

a. Surface-to-surface: launched from ground bases to attack ground targets; and

b. Submarine-to-surface: launched from submarines to attack ground targets.

The second method is to divide them into three types in accordance with their ranges.

a. Intermediate range: a range of 1,000 to 2,400 kilometers;

b. Intermediate-long range: a range of 2,400 to 5,600 kilometers; and

c. Long range: a range of 5,600 kilometers and above.

The so-called intercontinental missiles usually denote surface-to-surface long-range ballistic missiles with a range as long as 8,000 kilometers, among them the maximum range being 14,000 kilometers. However, the criteria by which countries differentiate ranges are not completely identical.

Naturally, the longer the range of the missile the heavier its warhead and the bigger its size and weight. For example, the largest intercontinental missile at present is 36.6 meters tall, has a diameter of 3.35 meters, and weighs more than 200 tons. Below is a separate introduction to two types of strategic ballistic missile, the ICBM and the submarine-to-surface missile.

(4) ICBM: The intercontinental missile is a strategic missile that was developed fairly early and is fairly mature. and it is also the most important part of the current strategic nuclear forces. As early as the late 1950's, the Soviet Union and America were equipped with the first batch of intercontinental missiles. Through 20 years of constant improvement and replacement, the intercontinental missiles with which they are equipped have now reached a very high level of tactical and technical performance.

The existing intercontinental missiles are installed in launch positions that resemble silos (Fig. 7-11). These underground launch silos are built to be extremely strong, and the capacity of some silos to resist a shock wave with a pressure of more than 140 atmospheres (140 kilograms per square centimeter). Unless an incoming nuclear warhead hits the silo very accurately, it is difficult to destroy the missile in it. In peacetime special units guard the missiles and their positions, which are kept in a state of constant alert. On the eve of war, further prelaunch inspections are made. When the order to



launch is received, within one minute the silo cover is opened, the engine ignited, and the missile launched directly from the silo. This form of launch is called a "hot" launch. If a high-pressure gas is used to propel the missile out of the silo and the engine is ignited afterward to cause the missile to continue its upward flight, it is called a "cold" launch.

There are many advantages in having a missile in a fixed launch base:

First, the distance of the target from the launch point, its position, as well as changes in the gravitational field can be measured fairly accurately, all of which gives the missile a fairly high degree of precision in hitting its target, in some cases a precision of about 200 meters.

Second, the launch silo can be made somewhat bigger, so that the missile can also be very large, can carry a fairly large warhead (or fairly many small warheads), and can fly very far.

The two characteristics of high precision and large equivalence give the intercontinental missile the capability of striking "hard" targets like missile silos. Therefore, once a nuclear war breaks out, it is very probable that this weapon will be the first one to be used, in order to destroy the enemy's command centers and missile silos, thereby depriving him of the ability to mount a strategic counterattack.

There is also a drawback in a fixed launch point, namely, it is easily attacked by the other side. This is an extremely serious problem. Under present conditions, to avoid the other side's attack so that the missiles survive a nuclear strike, the only feasible method is to adopt a mobile launch mode.

By a mobile launch mode is meant the designing of a special means of delivering the missiles (like vehicles, ships, and aircraft), so that the missiles are able to move on land, at sea, or in the air, and be launched at preselected launch points. Delivering them by vehicle is called land mobility, delivering them by ship or submarine is called sea mobility or underwater mobility, and delivering them by aircraft is called air mobility. Although a mobile launch entails many new difficulties, it greatly improves the missile's capacity for survival, and therefore it has received a lot of attention from many countries. The Soviet Union has already deployed a land-mobile intermediate long-range missile codenamed the SS-20, and America is developing a mobile intercontinental strategic missile codenamed the MX.

(5) Submarine-to-Surface Missile. The submarine-to-surface missile is an underwater mobile strategic missile that units were equipped with as early as the beginning of the 1960's. Because the nuclear-powered submarine submerges deep, is fast, and is able to cruise underwater for a long time, and because antisubmarine technology is, relatively speaking, still imperfect, people generally acknowledge that the submarine-to-surface missile is currently the strategic missile weapon system with the strongest capacity for survival. Particularly in the past several years, because of fairly large progress in reducing the submarine's noise, increasing its speed and range, and improving

the accuracy of its missiles, the submarine-to-surface missile has received an increasing amount of attention.

The usual guided missile nuclear-powered submarine has about a dozen launch tubes, each loaded with one missile. In receiving launch orders from the command organization, the submarine is helped by a special communications system. When a missile is launched, high pressure gas propels it to the surface of the sea, after which the missile's engine is ignited to continue its flight. At this time the submarine maintains a speed of 3 to 5 knots at a depth of about 30 meters. The most prominent virtue of equipping a nuclear-powered submarine with missiles is that it provides the submarine-to-surface missile with a strong capacity for survival, but it also entails some defects, which mainly are:

Target-hitting precision is fairly low, because the submarine's position cannot be determined as accurately as the position of a fixed launch point. Currently, the highest precision of a submarine-to-surface missile in hitting its target is about 400 meters. Thus, it can only be used to strike "soft" targets like cities, airfields, and ports.

The body of a submarine cannot be very thick and its missiles cannot be very big, so the submarine-to-surface missile cannot attain the range of an intercontinental missile and also cannot carry such a heavy warhead as the latter.

A submarine must return to port at regular intervals for overhaul, and its crew must be given rotational periods of rest, both of which requirements lower the number of submarines on combat-readiness duty. Of the comparatively advanced ballistic missile nuclear-powered submarines, now during peace times only about 50 percent of them are on patrol mission at sea. In an emergency situation, at the most only 80 percent of these submarines could be put out to sea.

#### B. Strategic Cruise Missile.

Around 1960, America built and equipped its units with several strategic cruise missiles, but because their performance was too poor, coupled with the fact that enormous success had been obtained with the strategic ballistic missile, these cruise missiles quickly fell into disuse. In the past several years, on the basis of high-precision guidance technology, small and efficient turbofan engine technology, and warhead miniaturization technology, America has developed a new-type strategic cruise missile that can be launched from land, sea, or air. The tactical and technical performance of this cruise missile is good, production of it is now being organized, and units will begin to be equipped with it.

A cruise missile is no more than 6 or 7 meters long, has a diameter of 60 to 70 centimeters, and weighs 1,300 kilograms, but it is able to carry a nuclear warhead of 200,000-ton equivalence and fly 2,500 kilometers with a target-hitting precision of about 30 meters. Because it is light in weight and small in bulk, a large aircraft or submarine can carry a dozen to several dozen of them. Because its bulk is small and it is able to fly at minimum altitudes,

and also because it is able to go around a fixed defensive position in accordance with a program worked out beforehand, and in addition because its manufacturing cost is fairly low and it can be used in large numbers, it will create very big difficulties for the enemy's air defense. Its main drawback is that its flying speed is fairly low, usually being 800 to 900 kilometers per hour.

#### C. Technical Support

For the launching of strategic missiles and the completion of their combat missions, not only is a highly trained guard and operation contingent needed, but also there must be a complete set of technical equipment and facilities, such as aiming, checking, and launching equipment, as well as various other kinds of ground equipment. The general designation for missiles with the addition of all these things is a weapon system. Only by the coordinated action of this weapon system can missiles be launched in good time.

However, the launching of missiles is not equivalent to the completion of a combat mission, which requires the effective destruction of the predetermined targets. For this reason, a series of difficult technical problems must be solved, such as: getting a clear idea of the number, nature, and sites of the enemy's strategic targets; accurately determining their distances and directions; setting up perfected command, control, and communication systems, and so forth. After some 20 years of hard work, and with the aid of artificial satellites and the newest achievements in the fields of optics and electronics, these problems have been basically solved. For example, the use of photographic reconnaissance satellites and electronic satellites has solved the problem of discovering and distinguishing strategic targets; geodetic satellites have been developed that accurately determine data on the earth's shape and gravitational field, and thus obtain the distance and direction between specific points on the earth; by means of navigation satellites, ships when navigating on the water and aircraft when flying can find their precise positions; with the aid of satellites, leading military organizations can hear, see, and command military operations in all places in the world; and by using early-warning satellites to constantly monitor the enemy, once the enemy launches strategic missiles this can be immediately discovered. In addition, the radar stations and optical observation stations built on the ground monitor the increase and decrease in the number of manmade objects in space and the changes in their patterns of movement, timely discovering and tracking all targets that pose a threat. All of these things are indispensable technical support for the strategic missiles to fully play their role in actual combat.

#### D. Defense Against Strategic Missiles

There are different ways of defending against strategic ballistic missiles and defending against strategic cruise missiles.

A ballistic missile is fast, highly accurate, and very powerful. To depend solely on concealing and reinforcing the strength of certain facilities cannot basically solve the problem. The most ideal method is to devise a way to intercept incoming warheads midway and render them ineffective. If this idea

is successful, it will, without a doubt, give the side that employs it a very great superiority in the balance of nuclear forces. For this reason, the Soviet Union and America for some 20 years have unceasingly explored and tested this idea.

The method they have thought of is to have a missile meet an incoming warhead head-on, and this means making an antiballistic-missile missile. This kind of missile is also a strategic missile. In shape there is not much difference between it and a surface-to-air missile that is used to intercept intruding aircraft, but the demands on it are much higher. At the present time, most aircraft speeds are under 3 times the speed of sound, but the speed of an incoming warhead of a strategic ballistic missile is about 12 times the speed of sound, and there are many devices to breach the defense (for example, using dummy warheads as bait). Therefore, to intercept warheads, early-warning satellites and long-range early-warning radar must discover as soon as possible warheads that are several thousands of kilometers away. Then, within several minutes, a series of actions must be completed, namely, distinguishing true warheads from dummy ones, getting a clear idea of their number, launching interceptor missiles, guiding them into the path the warheads must take, and blowing the warheads up in good time. It is not hard to imagine how difficult it is to do all of these things without the slightest error. Therefore, up to today, there still has not been made a very effective antiballistic-missile missile.

The flying speed of a cruise missile is close to that of an aircraft, but it is very small in bulk and can fly at minimum altitudes. Therefore, the ground radar used in the existing air-defense systems is unable to discover it at an early time. For this reason, there must be deployed in the air (for example, on aircraft) radar that "look down"; and there must be deployed interceptor aircraft that can launch air-to-air missiles downward, or surface-to-air missile systems on the ground that can intercept targets at low altitudes. However, the cruise missile also has the characteristic of being able to change its flight path, which makes it difficult to anticipate from what direction it will come in for the attack. Obviously, to intercept cruise missiles so as to insure the country's security, the above-mentioned air warning systems must be used and all of the country's long boundary line must be monitored. This is not something any country can do easily.

Thus it can be seen that, no matter whether it is against a ballistic-type strategic missile or a cruise-type strategic missile, no effective method of interception has yet been found. Now the Soviet Union and America are, on the one hand, doing research on laser, particle beam, and other beaming weapons in the hope that they will be able to deal with nuclear missiles; and, on the other hand, are building various kinds of strong civil defense projects in the hope of lessening the losses in a nuclear war and preserving their own forces.

Nuclear weapons possess enormous destructive power. The strategic ballistic missile is an extremely important strategic strike force. Precisely because this is the case, in today's international community, whether a country has strategic missiles, and if so how many and of what kind, to a certain degree is regarded as an indicator of how strong its military force is. The hegemonists, who have blind faith in nuclear weapons, even regard the

strategic ballistic missile as the "decisive means of winning a future war." On the one hand, in the name of "limiting" nuclear weapons, they hold talks and sign treaties one after another in an attempt to bind the other side and deceive the peoples of all countries; on the other hand, they spare no manpower and material resources to develop and equip themselves with more numbers of and more advanced missile nuclear weapons. The arms race for nuclear superiority steadily increases. We cannot regard this harsh reality lightly.

On 16 October 1964, relying on its own strength, our country successfully exploded its first atomic bomb. On 27 June 1967, our country exploded its first hydrogen bomb and, following this, successfully developed guided missiles. In May 1980, our country obtained complete success in its test-launch of a long-range carrier rocket into the middle of the Pacific Ocean. In September 1981, our country succeeded in launching three artificial satellites from a carrier rocket; and in October 1982, a submarine of our country's successfully launched a rocket booster from under the sea. These successes broke the nuclear monopoly of imperialism and hegemonism, greatly boosted our military and national strength, greatly heightened the aspirations of the Chinese people, and also made valuable contributions to the safeguarding of world peace and to the comprehensive banning and thorough destruction of nuclear weapons.

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